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ARMY ORDNANCE

VOL. VI WASHINGTON, D. C., JULY-AUGUST, 1925 No. 31

MODERN ORDNANCE NEGOTIATING A MOUNTAIN PASS IN HAWAII

Photo: Signal Corps, U. S. A.

ORDNANCE SERVICE IN PANAMA
MAJ. O. J. GATCHELL, Ord. Dept., U. S. A.

ORDNANCE ACTIVITIES IN HAWAII
MAJ. W. L. CLAY, Ord. Dept., U. S. A.

ORDNANCE AT SCHOFIELD BARRACKS, HAWAII
MAJ. JAMES KIRK, Ord. Dept., U. S. A.

SMALL ARMS MAINTENANCE IN PANAMA
CAPT. ROY L. BOWLIN, Ord. Dept., U. S. A.

MILITARY AND COMMERCIAL POWDER AND EXPLOSIVES
COL. W. C. SPRUANCE, Ord. Res.

SEVENTH ANNUAL MEETING OF THE ARMY ORDNANCE ASSOCIATION, ABERDEEN PROVING GROUND, OCTOBER 2, 1925.

AOA
THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

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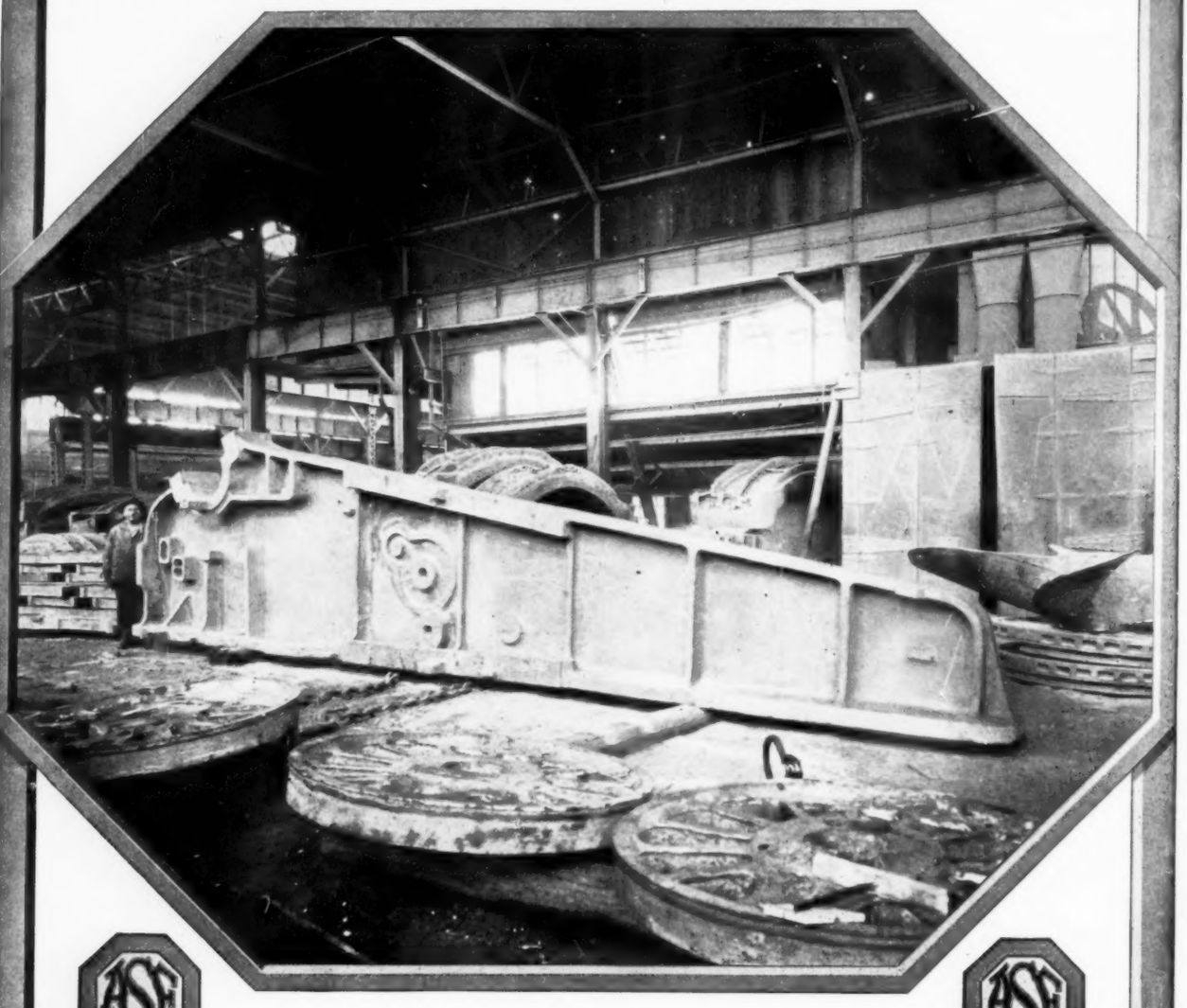

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NEW YORK CHICAGO ST. LOUIS

ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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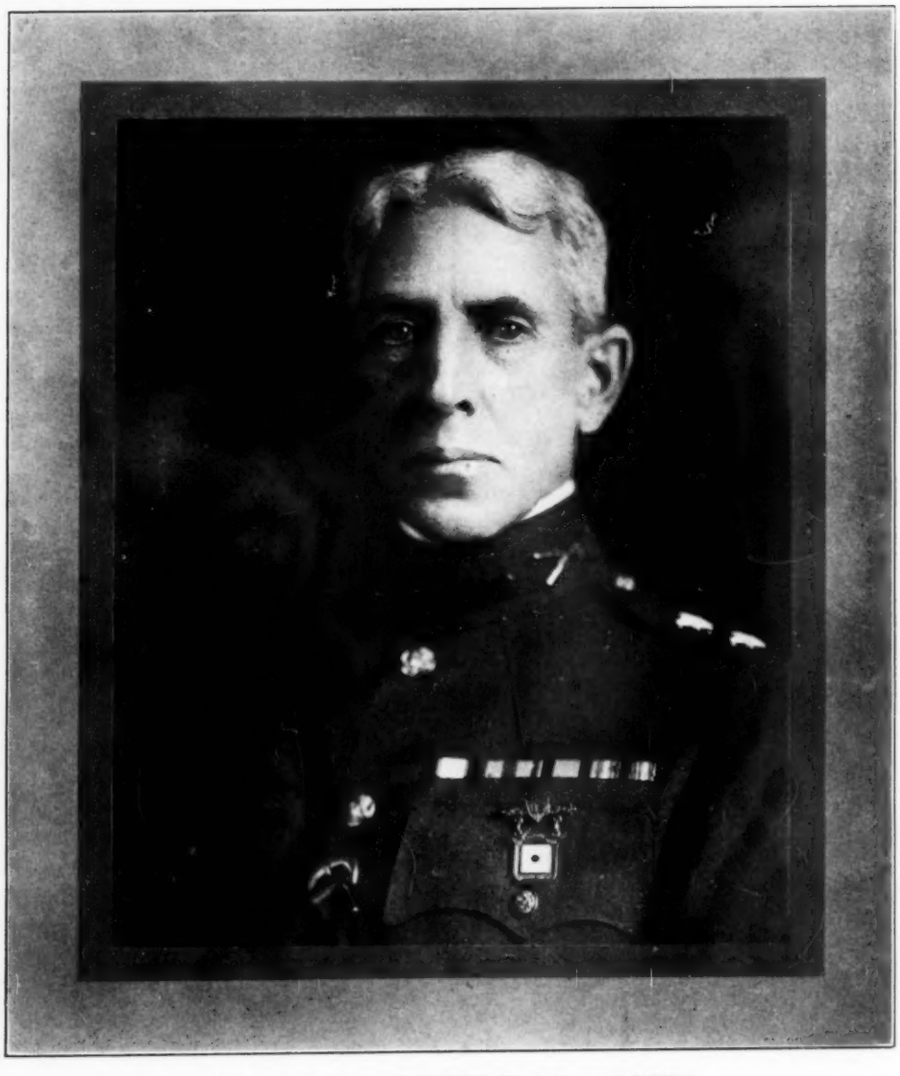


MAJ. GEN. ROBERT H. ALLEN
Chief of Infantry, U. S. A.

Major General Allen, Expert Rifleman

By

MAJ. ROBERT SEARS, ORD. DEPT., U. S. A.

MAJOR GENERAL R. H. ALLEN, the new Chief of Infantry, is an ardent sportsman, possesses an exceptional physique and, unlike most men who have developed their own skill to a high degree, he derives more pleasure in developing others than in perfecting himself. He is a born leader, able to exemplify as well as to direct. Not the least of his hobbies is shooting, and it is doubtful if any man has ever possessed more all-round knowledge of this greatest of all military sports.

General Allen (then Captain Allen, 29th Infantry) began his shooting career as an alternate on the Infantry Team in 1909. In 1910 the Infantry had one of the best teams that they had ever entered in the National Matches. This team led the matches with a score of 3,186, which was 71 points ahead of the second team. Not only as Coach was Captain Allen largely responsible for the unusually good showing made by this team, but as a shooting member he made one of the highest scores in the matches.

In 1911, Captain Allen was Coach of the Infantry Team which placed second in the National Matches. This same year he won the Hale Match at 600 yards with 21 consecutive bull's-eyes.

In 1913, Captain Allen was Team Captain and Coach of the Infantry Team. Due to his influence, this team turned out to be exceptionaly promising, and at the National Matches, after the 200-yard Surprise Fire, 600 and 1,000-yard Slow Fire, had a clean lead of 34 points over its nearest rival. Then came the skirmish, and one of the bitterest tragedies the Infantry has ever had to endure in rifle competition. Captain Allen, assisted by the best shots on the team, estimated the wind at 2¼ points, left. He had his powerful telescope trained on the target of a man who was known to have an exceptionally accurate rifle. This man's two shots at 600 yards were seen to be absolutely center for windage, so naturally Captain Allen was justified in assuming the wind dope correct and so notified the team. What actually happened was this. The estimate was ¼ point too little left windage, and the particular rifle which Captain Allen was depending on had, as rifles sometimes do, changed its zero since last fired and was the only rifle which made a creditable score. The team shot only 909, the lowest skirmish score made by an Infantry Team, and the team dropped to eighth place. No one felt the blow more keenly than Captain Allen, but as evidence that confidence in his ability as a Coach had not weakened, he was selected as one of the two Coaches of the American Palma Team, which was to shoot a few days later for the Historic Palma Trophy, emblematic of the long range rifle championship of the world.

The day before the Palma Team Match, the individual Palma Match was fired, each member of the Palma Teams firing the course as an individual. The result of this day's firing showed the Canadians to be superior to any other country as individual riflemen. The atmospheric conditions were perfect, and it looked as if the Canadian Ross Rifle with its special hand-loaded ammunition and 215-grain bullet would be unbeatable. The American Team decided then and there that the Model 1909 Springfield Rifle with its 180-grain bullet was ready for the scrap heap, and so advised Major Thompson, the Ordnance Representative of the National Matches, who was considered more responsible than any other one man for the American rifle and ammunition. Major Thompson put up a gallant defense, but was voted down unanimously by the American Team, and was politely told to take his inventive proclivities into some other field. Then the day of the Match arrived and an ugly wind sprang up from the North. No better day could have been picked for conditions which would call for every atom of ability to dope the wind. The Canadians' Captain cocked his weather eye and said, "This wind is coming right from Canada and we feel very much at home; our 215-grain bullet was made especially for these conditions." There were two coaches for each team, and each coach had one target and four riflemen. Captain Allen was the busiest man in the world that day. The wind would shift from ten to two o'clock, and from ten to thirty miles an hour so quickly that it was frequently necessary to shift anywhere from seven points left to seven points right between the time of setting sight and firing, which ordinarily takes about thirty seconds. The shooters did nothing but take the dope from the coaches, hold hard and squeeze, and the results of that day's firing are simply a record of three things—coaches, rifles and ammunition. Captain Allen, without question, showed himself on that occasion to be one of the greatest coaches in the rifle game. His target led the next highest by 15 points and was the only target that did not have a miss.

In 1919, General Allen, then Colonel Allen, was chosen to coach the A. E. F. Rifle Team which was to participate in the Inter-Allied Matches. The supremacy of the United States was more evident in these matches than it had ever been before, as evidenced by the statement of M. Celisse, one of the foremost veteran marksmen of France, who helped train the French Team and was one of the most interested spectators at the meet. "The Americans," said he, "won, first, because they have an excellent system of training and pursue it indefatigably, and second, because of the superiority of the Springfield Rifle."

The Seventh Annual Meeting

of the

Army Ordnance Association

will be held at

The Aberdeen Proving Ground, Maryland
Friday, October 2, 1925

We are privileged to have with us as participating guests the Franklin Institute, the National Aeronautic Association, and the National Machine Tool Builders' Association.

Detailed information concerning the program of events, special trains and meals, will be published in the September-October number of ARMY ORDNANCE. Members of the Army Ordnance Association and guests will be furnished the complete program at an early date.

Reserve This Date

October 2, 1925

Photo by Army Air Service

Airplane View, Panama Ordnance Depot

Ordnance Service in Panama

By

MAJ. O. J. GATCHELL, ORD. DEPT., U. S. A.

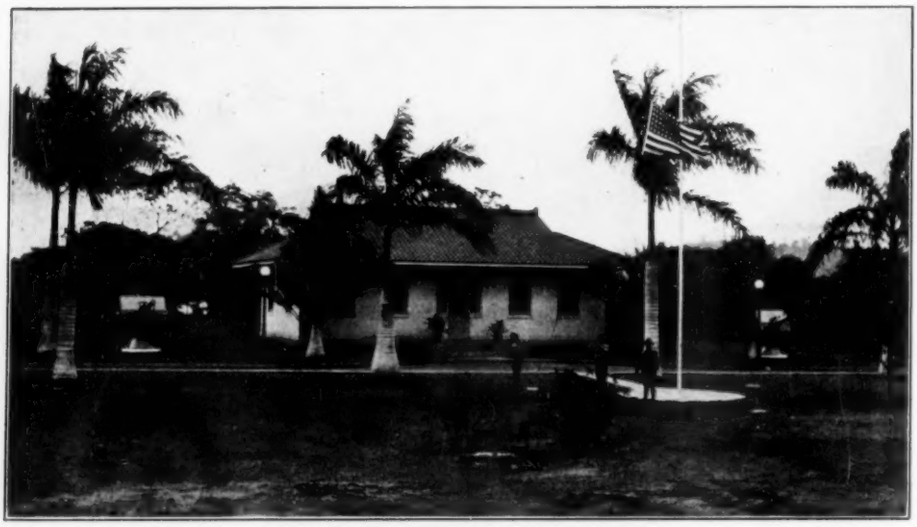
SERVICE in the Canal Zone is in most ways delightful. Living conditions are pleasant and the work is varied and interesting. The climate is agreeable to most people, although of course there are times when one longs for the cool bracing air of a northern clime, and those of younger and redder blood crave snow and ice.

The great bug bear of the tropics in the minds of most people is the climate. By reputation, Panama is unbearably hot and humid. As a matter of fact it is the monotony of heat rather than its severity which is somewhat of a hardship. But even the monotony is not wholly continuous, for there are two distinct seasons,—the dry, from the middle of December to the middle of April, and the rainy, during the remainder of the year. The two periods of transition are the worst times in the year. The months of December and April combine the higher temperature of the dry season with the greater humidity of the rainy season without the tempering trade winds of the former nor the cooling effect of the rains prevalent in the latter.

It seems to be a local condition that a resident in any one particular locality fully believes that where he lives is preëminently the best part of the Isthmus. It is a fact that the climate and living conditions vary considerably in the short space of 50 miles which separates the Atlantic from the Pacific. It should be borne in mind, therefore, that this article applies particularly to the Panama Ordnance Depot, which is on the Pacific side and is the center of Ordnance activities in the Zone, and is not altogether the personal opinion of the writer, but is based upon the concensus of opinion of those who live at the

Depot. Some of those who have been consulted in this respect have lived at the Depot for four years or more.

The climate in the Canal Zone depends a great deal upon the specific location, but at the Depot it is not found to be excessively hot. The temperature indoors normally ranges from 75 to 85 degrees in the day time, and the nights are always comfortable. During the rainy season it rains nearly every day, but only for a short time. One becomes accustomed to this rain and in fact rather looks forward to it because of its cooling effect. The bright glare in the dry season is found objectionable by many, so that taking it all in all it is found that opinion is about equally divided as to which season is the more



Headquarters, Panama Ordnance Depot

desirable. During the rainy season the moisture is excessive and is probably the most disagreeable feature of service in the Canal Zone. Precautions have to be taken at all times against mildew and other similar conditions. The quarters are furnished with "dry closets" in which an electric light is kept burning twenty-four hours a day.

During both the dry and rainy seasons the heat is not felt if one sits still indoors, with free ventilation. Nor is it particularly disagreeable during exercise if one is suitably dressed. But if required to be out of doors in the sun in uniform, or indoors out of the breeze, the heat together with the humidity produces a disagreeable realization that one is in the tropics.

Many scientific articles have been written about the effect of the actinic ray of the tropical sun upon white people, but it seems to be more fancy than fact. The glare of the sun, particularly in the dry season, is really very disagreeable to the majority of people, and it is prudent to wear colored glasses when in the sun for any length of time, and for those who habitually wear glasses it is almost essential to have them equipped with the Cruxite lenses.

It is generally recognized that during a tour of three years, at least one leave of absence with a visit to the States or to the cool mountains in Costa Rica is desirable. Prolonged stay in the tropics without a leave is said to produce absence of mind, nervousness and laziness. If leave is taken periodically most people seem to be able to stay indefinitely. There are many Canal employees and some Army employees who have lived in the Zone many years with apparently no ill effects. Several of the civilian employees in the armament maintenance force have served nearly ten years, and one has been in the Zone over twelve years. It is believed that their daily output and the quality of their work compares very favorably with others who have not been exposed to the tropical climate. However, without periodical trips to the States it is doubtful if this would be possible.

Opinion seems to be unanimous that exercise is essential to health in the tropics. Office hours are from 7 a. m. to 1 p. m., so there is ample time to get the requisite exercise. Riding horses can be obtained, there is a fine tennis court at the Depot, two 18 hole golf courses are within easy automobile distance, two fresh water swimming pools are not far away, and there is a salt water bathing beach at Fort Grant, about six miles away. Deer, wild boar, ducks and the native rabbit or *canejo* lure the hunters, together with an occasional crocodile hunt. Deep sea fishing is also available. In their seasons (which, incidentally, do not conform to those in the States) there is much baseball, soccer, basket ball and boxing.

There is little sickness, particularly among children. Colds, when contracted, are hard to shake off. There seem to be an endless variety of skin diseases which can occur on the least provocation. If unfortunate enough to become in need of hospital attention there are two good ones,—Ancon Hospital, operated by the Panama Canal, and the Hospital de Panama, in Panama, under the direction of a clinic of American doctors.

When one considers that not so many years ago this country was a dense jungle, infested with mosquitoes and other insects and alive with yellow fever and malaria, it is hard to believe that it is now possible to attend a dinner at the Hotel Tivoli, on the unscreened pergola, with not a sign of an insect. There has been no yellow fever since 1905 and malaria is less prevalent than in many localities in the States. There are very few flies and practically no harmful mosquitoes. Nevertheless the houses are very carefully screened. There are some very small black mosquitoes and sand flies which come through the screens. These are very annoying at times but are harmless as disease producers.

The marvel is that, in so short a space of time, one of the pest holes of the world has been converted into what statistics prove to be a health resort.

It must be borne in mind, however, that it is only by experience that health-producing rules of living have been determined. One must profit by this experience of others and adapt himself accordingly or bad effects will result in course of time.

The Ordnance Depot is located on the Canal about two miles from the Pacific end. Contrary to the popular conception, the Canal does not run east and west, but southeast and northwest in such a manner that the Atlantic end is actually west of the Pacific end. The topography from the Continental Divide to the Pacific is rather peculiar, consisting of groups of steep hills of volcanic origin interspersed with low level stretches. These hills look like gigantic ant hills and average about 300 feet high. The divide itself which is about twelve miles from the Pacific averages about 600 to 800 feet. The famous Gaillard or Culebra Cut is through the Continental Divide, which is part of the great chain of mountains of which the Rockies and the Andes are a part. At the Pacific end of the Canal on the southeast side are two steep hills about 600 feet high, known as Ancon Hill and Sosa Hill. The Canal Zone towns of Balboa and Ancon and the City of Panama surround these two hills. To the south there is a huge fill made from excavations from the Canal on which is located the Coast Artillery post of Amador and Division Headquarters. Two miles farther south are the "Fortified Islands," now connected with Fort Amador by a causeway also made by material removed from the Canal prism. On these four islands—Flamenco, Perico, Culebra and Naos—are placed the batteries defending the Pacific end of the Canal, and together they are called Fort Grant. Fort Amador has practically no armament but houses the garrison for Fort Grant.

Shop Buildings, Panama Ordnance Depot

Grouped with the Ordnance Depot at Corozal is the Engineer Post of Corozal together with the other depots except medical. About 1½ miles farther north along the Canal is Fort Clayton, a regimental infantry post. Another regiment of infantry is stationed at Camp Gaillard on the west side of the Canal near Culebra Cut.

At the Atlantic side are the Coast Artillery posts of Forts Sherman, Randolph and DeLesseps, a regiment of Infantry at Fort Davis, a battalion of Mountain Artillery at the Camp at Gatun, and the Air Force at France Field. The Canal Zone towns of Cristobal and Gatun and the Panama city of Colon are at the Atlantic end of the Canal.

The railroad station and Post Office for the Ordnance Depot are at Corozal, about one-quarter mile distant. The Panama Railroad runs three trains a day each way across the Isthmus. The railroad parallels the Canal most of the way, and the trip takes about two hours.

The railroad is the only means of crossing the Isthmus by land, since there is no road all the way across. Some day there may be one, but so far the wide expanse of Gatun Lake intervenes. But all other travel is by automobile. There are excellent roads everywhere. The Depot has no official passenger car and transportation necessary for official trips is obtained from the Motor Transport Pool at Corozal. This transportation is so limited that most officers depend upon their own cars. There are numerous "jitneys" but their constant use is not economical. At the present time the Post Exchanges of Corozal and Fort Clayton and elsewhere are operating busses. It is understood that very probably at the beginning of the next calendar year an extensive system of bus transportation is to be installed, operated by one company. This may result in uniformly moderate fares and better service. At the present time, however, it is desirable for one to bring his own car. New automobiles cost more in Panama than in the States because of freight and duty, and good used cars are almost impossible to obtain. Formerly an automobile could be brought on an Army transport free of cost except for the freight across the Isthmus amounting to $1.25 per 100 lbs. Recently, however, a ruling has been made requiring payment of freight charges, and it is believed that commercial shipment via the Panama Railroad boats is cheaper, the total cost from New York to the Depot amounting to about $60 for an average car.

The Depot is on level ground about 30 feet above the Canal. The nearest buildings, the officers' quarters, are about 150 yards away, so that all vessels in transit appear to go through the front yard of the Depot. The first two lifts of the locks are at Miraflores about two miles north of the Depot. There is a small lake between the Depot and the locks which serves the double purpose of permitting cool breezes to blow and affording a night view of the illuminated locks which rivals Broadway. Altogether, the location of the Depot is fine, and it is as cool there as anywhere in the Zone.

All Ordnance officers in the department are quartered at the Depot. There are two large sets of concrete quarters, exactly alike, for the two senior officers. These quarters are the equal of any in the Canal Zone and are far better than many.

Unfortunately, however, the gap between these two sets of quarters and the quarters for the other officers is considerable. The other three officers are quartered in small

five-room bungalows which were originally built for non-commissioned officers. These quarters are comfortable and in good repair, but are small for a family of any size. There are four more of these buildings and a wooden four-set apartment house of five-room apartments for the warrant officers and non-commissioned officers. These quarters compare very favorably with the quarters assigned elsewhere for enlisted personnel. The entire quarters condition in the Canal Zone is very crowded and, generally speaking, conditions at the Depot are superior to those at other posts.

Commanding Officer's Quarters, Panama Ordnance Depot

The foods in the Canal Zone are not so very different from those in the States. Prices are in the total probably less, although some things are higher. Meats, for example, are very cheap, but also cheap in quality. It is practically impossible to get a decent roast of beef. Ham, pork, veal and chicken are of good quality. The vegetables are only fair. The local gardens do not seem to be able to produce high quality vegetables except those native to the climate, and for American vegetables dependence is largely placed upon those which come from the States. They can be obtained at various seasons immediately after the arrival of boats. Some of the local vegetables are excellent after a taste for them has been acquired. Most of the fruits grown in the States can be obtained, but those which spoil quickly are on hand only immediately after the arrival of a boat, and are not in general stock. Tropical fruits, such as bananas, pineapples, oranges, mangoes, alligator pears, papayas, cocoanuts, and limes are abundant and cheap. In season, a good alligator pear costs 5 cents at retail, and if one goes down to the market where the boats come in from the country, they can be readily obtained at the rate of two for 5 cents. Native oranges get as low as $1 a 100 at these boats during the height of the season.

In general most heavy clothing should be left in the States. But it is advisable to bring enough to permit return to the United States in winter if necessary, or to take leave in Costa Rica or some of the South American countries which are mountainous and cool.

The climate causes silver to tarnish very quickly, but proper care and storage in a "dry closet" will keep it in good condition. It is needed as there is considerable entertaining.

Rugs are not a necessity, many do not bring them at all, depending upon grass rugs obtained in the Chinese stores. However, they can be taken care of without much difficulty, and by most people are considered desirable.

It is very difficult to keep books in good condition. During the rainy season they are attacked by mildew, and at all times small insects have a particular liking for the glue in the binding. It is believed that no more books should be brought than are absolutely necessary.

Most of the nights are comfortably cool and some are decidedly chilly. If sleeping on the porch one light blanket and sometimes two are necessary nearly every night. It is believed that the best solution of the bedding problem is to have two blankets for each bed, one light and one heavy.

Articles such as pianos, overstuffed or veneered furniture and choice pieces which are glued together are better off in the States. If brought they will only be a source of care and are apt to be ruined. There is a variety of cotton moth which attacks overstuffed furniture. Valuable clocks should be left behind as the humid climate has a very bad effect on clocks and watches. With proper care other articles of household goods can be preserved in reasonable condition.

There are excellent schools in the Canal Zone, including a high school. The trips of the motor transportation which brings the employees to and from work are on such schedules that the children of the Depot can be carried to and from school.

There is a Baptist Church, a Roman Catholic Church and a Union Protestant Church in Balboa, and in Ancon are St. Luke's Cathedral (Episcopal) and a Christian Science Church.

Due to the fact that the Canal Commissaries pay no import duty, many articles can be purchased cheaper here than in the States. Chinese rugs, Royal Doulton and Minton china and imported linens, as well as a limited selection of oriental goods, are available. In the city of Panama there are some excellent Chinese and Indian stores where rugs, brasses, Chinese silks and articles of clothing can be bought at great saving. Most of these stores require bargaining, and it is advisable not to buy when first arriving in the Zone. A great deal of pleasure can be had in going around these stores and pricing and investigating, making small purchases from time to time so as to become accustomed to their method of dealing and with proper prices. These stores make their big profits from tourists and will make them from residents if they can, so it becomes desirable to know the game before attempting to play it. There are other very good stores operated by French and Spanish merchants which are "one-price" stores and which offer very fine French

and Spanish goods which come into the Republic of Panama at a much lower duty than is charged in the States.

There are daily moving picture entertainments at each post, and at all the Canal clubhouses, which are located in Balboa, Ancon and other towns, and there are some moving picture houses in Panama. Occasionally entertainments are given at the National Theater of Panama by South American artists who are on their way to the States to give recitals. The National Theater is the only theater in Panama.

There are four regular monthly dances at the Pacific end of the Canal, given by Department Headquarters at Quarry Heights, Post of Corozal, Fort Clayton and Fort Amador. Socially the Depot is considered as part of the Post of Corozal. Quarterly the four posts combine and give a large dance at the Union Club in Panama. This Club together with the Century Club and the Panama Golf Club furnish the club life at the Pacific side of the Isthmus. Panama is "wet" at reasonable prices and the clubs are quite popular. The Hotels Central and International in Panama serve good dinners and are patronized by many. The Hotel Tivoli in Ancon is run by the Canal and is excellent. It is an old wooden structure but very comfortable and serves excellent meals at reasonable prices. The Canal Zone is "dry" and rigidly so.

Barracks, Panama Ordnance Depot

The fact that the City of Panama is the capital of a republic provides special functions of a diplomatic nature which are largely attended by Army people.

Once a year, just prior to Lent, the native Panamans have a Carnival which lasts for several days and is rather interesting and enjoyable.

The City of Panama itself is of great historic and romantic interest. There are many places to visit which date back several centuries, such as the ruins of Old Panama, the flat arch in the old Church of Santo Domingo, the Church with the Gold Altar, etc. The city is typically Spanish-American but under American supervision is quite clean and sanitary.

About ten miles from the mouth of the Canal is the Island of Taboga. Here is a very quaint old village with a church which dates back many centuries. There is an excellent bathing beach at the village and, although Taboga is Panaman territory, the Hotel Aspinwall is run by an American and is frequented by tourists and week-end parties of residents from the Zone. There is one boat daily and on Wednesdays and Saturdays there are two trips of the boat. One peculiar thing about Taboga is that it does not get nearly as much rain fall as the mainland. It is a mountainous island, the peak being something over a thousand feet high, but there are some level stretches and the raising of pineapples is becoming quite an industry.

The Ordnance garrison in the Panama Canal Department consists of five officers, one warrant officer and 123 enlisted men. The enlisted men are organized into those master and technical sergeants carried at large and the 20th Ordnance Company (Maintenance), the 10th Ordnance Company (Maintenance), and one platoon of the 72nd Ordnance Company (Depot).

The five officers allowed by the War Department are: 1 field officer, Department Ordnance Officer; 1 captain, Divisional Ordnance Officer; 1 captain, in command of the 20th Ordnance Company; 1 lieutenant, in command of the 10th Ordnance Company; 1 lieutenant, Assistant Department Ordnance Officer. The civilian employees average about 18 American and 25 native.

As previously stated, the main activities of the Ordnance Department are concentrated at the Panama Ordnance Depot. The Department Ordnance Officer is also Commanding Officer of this Depot, instead of having a separate office at Department Headquarters at Quarry Heights. This has some disadvantages, but in general works very well, particularly as regards reducing the expense of clerical overhead. It requires only 15 minutes by automobile to go from the Depot to Department Headquarters. Routine matters are carried on by telephone or memorandum.

The Divisional Ordnance Officer also has his office at the Depot instead of at Division Headquarters at Fort Amador. In addition to his assignment as Divisional Ordnance Officer, he assists the Department Ordnance Officer by acting as Armament and Ammunition Officer for all divisional troops and as Department Small Arms Officer for the entire Panama Department.

The officer in command of the 20th Ordnance Company has very little to do in this capacity, since this company is split up into detachments at the forts in the coast defenses of Balboa and Cristobal. His principal work consists in assisting the Department Ordnance Officer as Armament and Ammunition Officer for the Coast Artillery and Air force.

The officer in command of the 10th Ordnance Company also commands the platoon of the 72nd Ordnance Com-

pany, both of which are stationed at the Panama Ordnance Depot. He, therefore, bears the bulk of the work of military administration. In addition to this duty he acts as Property Officer at the Ordnance Depot and is in charge of the Storehouse.

The Assistant Department Ordnance Officer also acts as assistant to the Commanding Officer of the Depot and Officer in Charge of Shops.

Main Road, Panama Ordnance Depot

As all officers are quartered at the Depot, they share the usual routine garrison duties of Adjutant, Quartermaster, Summary Court, Fire Marshal, E and R Officer, Post Exchange Officer, etc. By having all the ordnance officers together in this way, a very close contact is maintained by the various activities.

The 20th Ordnance Company does not function as a company, and is so organized for administrative control only. It is not organized or equipped to take the field, but functions in a manner similar to the old Ordnance detachments at Coast Artillery posts. Its work consists of the general maintenance of seacoast armament.

The 10th Ordnance Company is the divisional maintenance company, but performs its maintenance functions by manning the shops at the Ordnance Depot, thus reducing to a minimum the number of civilian employees required for this work. A few men are detached at the divisional posts. This company is trained to take the field in time of war with its proper equipment as a mobile unit, but since this procedure would rob the Depot shops of their personnel, and also since the tactical conditions do not require the services of the company as a unit, a compromise has been reached by assigning some of the repair trucks to various mobile organizations which they would join in time of war and function under the supervision of the Divisional Ordnance Officer.

The platoon of the Depot Company performs regular depot work, and in addition at present performs some of the duties pertaining to an ammunition company. It is hoped that in the not too far distant future the Depot garrison may be increased by the addition of a platoon of an ammunition company.

The Ordnance personnel in the Panama Canal Department is responsible for the storage and issue of Ordnance supplies for a peace-time garrison of approximately 9,000 men. This is the present reduced strength of what amounts to a division plus Coast Artillery troops and an Air Force. The facilities are adequate and nothing is abnormal from other Depots except that, since this is an area depot, the Ordnance Review System is not followed. The only particular features are that supply has to be anticipated further in advance, and optical instruments, watches and articles made of wood and leather require special storage in dry rooms and continuous observation because of the humid climate. Wood and leather are also subject to attack by insects.

In addition, however, to the normal storage and issue there is responsibility for the storage of a large amount of War Reserve. This is at present a large and important problem, particularly with respect to ammunition. Since the warm and humid climate of the Canal Zone has a very adverse effect upon ammunition, it requires constant surveillance.

The civilian organization for maintenance consists in general of an armament foreman, a resident and armament machinist at each seacoast post, one armament machinist for mobile maintenance work in the field, one armament machinist in the machine shop at the Depot, and one instrument maker at the Depot. One of the armament machinists on the Atlantic side, where the posts cannot be served conveniently by the Ordnance Depot, is also a qualified instrument repairman. There are also an armorer, an electrician and an automotive machinist at the Depot. For each civilian machinist there is a native helper. The remaining maintenance personnel consists, as stated above, of enlisted men, the 20th Ordnance Company at the seacoast forts and the 10th Ordnance Company at the divisional posts and in the Depot shops.

The two armament officers exercise their supervision through the armament foreman, who has direct control of the actual work performed. For work performed in the shops at the Depot, he assists the shop officer.

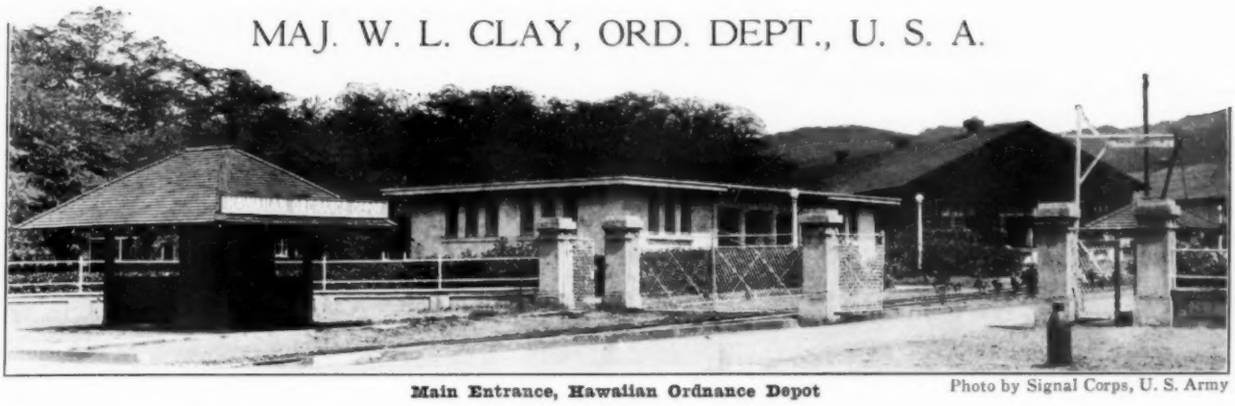
The maintenance of artillery matériel in this Department presents very few unusual or interesting features, and is carried on in a manner very similar to that in the States. Due to the constant rains during the major portion of the year, an unusual amount of preserving material is required. Also due to the effect of the tropical sun and rain, more than the normal amount of paint is needed. It has been found by experience that the ordinary canvas covers used for the protection of guns and carriages deteriorate very rapidly in the climate of the Canal Zone, and therefore penthouses have been constructed over the mortars. This experiment has proved very satisfactory.

Many in the Army dread a tour of foreign service, but it is believed that a large majority of those serving in Panama enjoy their tour and look back upon it afterward with real pleasure. It cannot be disputed that there are those whom the tropics affect adversely, but usually it is because they have not tried to adapt themselves to local conditions. In general, service in the Panama Canal Department is of great interest professionally, pleasant socially, and an educational experience which should be sought after rather than avoided.

Ordnance Activities in Hawaii

By

MAJ. W. L. CLAY, ORD. DEPT., U. S. A.



Main Entrance, Hawaiian Ordnance Depot Photo by Signal Corps, U. S. Army

THE history of the Ordnance Department in Hawaii necessarily follows a path parallel to that of the Hawaiian Department itself. As the personnel of the department has increased in numbers and as the matériel of the garrison has grown larger in quantity and variety, so have the activities of the Ordnance Department become wider in scope and greater in volume.

A complete study of the Hawaiian Department, from the establishment of Camp McKinley in 1898 by a small detachment of volunteers to the present garrison located in nine posts and comprised of every branch of the United States Army, presents a story, the telling of which would require a great deal more space than allotted this article. However, since a knowledge of the expansion of the department is vital to a comprehensive study of Ordnance activity, a short resumé is given of the various organizations which comprise, or have comprised, the garrison of the department.

Immediately after the decision of the government to annex Hawaii, the 1st New York Volunteer Infantry and 2d United States Volunteer Engineers were ordered to the Islands. These troops landed on August 16, 1898, and located at Camp McKinley in one of the parks of the city. On April 18, 1899, three batteries of the 5th Artillery, Regular Army, arrived and were also stationed at Camp McKinley. Although this camp was never more than a temporary garrison, no decisions regarding a permanent post were made until 1903 when a territorial reservation was chosen as a site for the location of troops. Fort Shafter, as the post was designated, was first occupied by the 2d Infantry, in June, 1907.

The period from 1907 to 1913 may be passed over rapidly, the principal work in the department being the reclamation of land, the erection of buildings and batteries and the other labor incident to the occupying of new posts.

At the beginning of 1914, Forts Shafter, Armstrong, DeRussy, Ruger, and Kamehameha were occupied and garrisoned by troops. Batteries of various types had been completed and were manned. Schofield Barracks was a three regiment post, having stationed there the 5th Cavalry, 2d Infantry and 1st Field Artillery.

During the period of the World War, but few Regular Army troops remained in the department, all forces having been ordered to overseas duty with the exception of the units of Coast Artillery necessary for manning the batteries of the seacoast defenses. However, in September, 1918, a squadron of Air Service was sent to Hawaii to assist in the defense of the forts and was stationed at Fort Kamehameha.

A year later, the 17th Cavalry arrived and was assigned to Schofield Barracks. The forces were augmented during the summer of 1920 by the coming of the 35th Infantry to the Islands, and in January, 1921, by the arrival of the 21st and 27th Infantries and the 8th, 11th, and 13th Field Artilleries. The entire garrison of Schofield Barracks was formed into the Hawaiian Division on February 28, 1921, which division was made complete late in 1922 by the arrival of the 19th Infantry.

Two mobile units were organized during 1921 from Coast Artillery forces of the department; the 3-inch Antiaircraft Regiment, afterwards designated the 64th Artillery, being organized during early spring, and the 41st Railway Battalion being formed as of January 1, 1922. In addition, a regiment of 155-mm. gun artillery (55th Artillery) arrived during this period. All were given station in the posts of the coast defenses.

No changes have been made in the garrison since 1922. Two important additions to the armament have been made, however, a major caliber gun battery having been completed at Fort Weaver during the summer of 1924, and 240-mm. howitzers proof fired on fixed mounts in tests for all-around fire. This in very brief form is the history of the Hawaiian Department.

To care for the ordnance armament at Hawaii, a well organized institution is required. This institution not only must supply replacements of matériel and the parts

for it, but must maintain the armament in the best possible condition, and, in addition, must handle and store the large quantity of matériel and ammunition for general reserve purposes.

This organization functions under two heads, the Department Ordnance Office which is responsible for the maintenance of matériel and the Hawaiian Ordnance Depot responsible for supply. While these two sections are separate and distinct, yet, since their activities are so closely allied, strict segregation of duties is somewhat difficult. Both offices are situated in the same building, are composed of the same personnel, and are commanded by the same commanding officer. The records of the two offices, however, are kept separately so as to permit a physical separation, if such should be desired at any time.

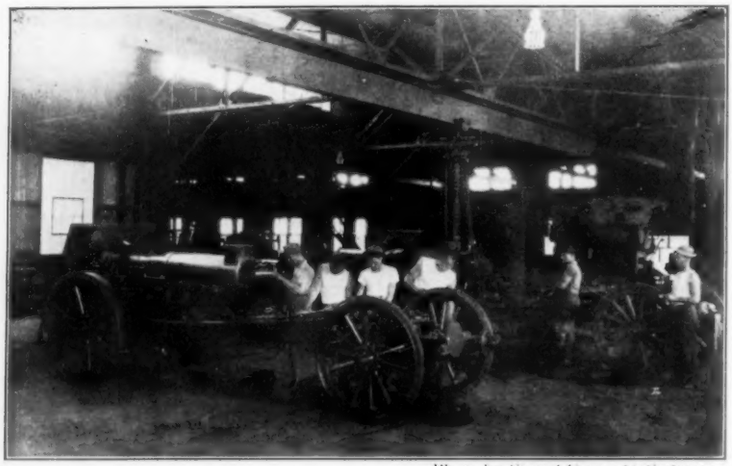


Photo by Signal Corps, U. S. Army

At Work in the Gun and Carriage Section, Ordnance Shop, Schofield Barracks

Perhaps the greatest duty of the Department Ordnance Office is caring for the armament in service and in reserve. The Armament Section is composed of all the civilian personnel of the shops throughout the department and of the clerical force necessary to care for the records of the section. The duties of this section are varied. It has charge of the shops in the department and of the work performed therein. All armament inspections are carried out by this section, each post being visited at least once per annum, at which time the matériel is thoroughly inspected and recommendations made as to improvement and repair. All orders for modifications of matériel from whatever source are prepared or checked before issue to the various stations. All blueprinting and drafting is performed here. This section is charged with receiving, filing, and issuing drawings, publications pertaining to the armament, letters of revisions, etc. It is responsible for the assembling and mounting of matériel and for the proof of same insofar as the Ordnance Department is concerned. At least one representative is present at all target practices in order that expert advice may be available to the using service.

Ammunition is cared for separately under the direct supervision of an expert whose time and knowledge are utilized solely in this work. He is charged with the issuing of safety precautions for the department in the care and handling of all ammunition and explosives. He is responsible for all modification work pertaining to seacoast, mobile, and small arms ammunition, bombs, grenades and pyrotechnics. Experimental work with ammunition and its components and the unloading of high explosive shell is personally supervised by him.

Another phase of Department Ordnance activity is the keeping of records which pertain to matériel and military personnel. Files are kept of all firearms in the department so that the exact location of each is known. Ammunition reports and the report of principal ordnance stores are charged to this section, the reports of the various stations being checked, consolidated and forwarded to higher authority. It is also responsible for the records of enlisted personnel and drafts all orders pertaining to their assignment, change of station, transfer, promotion, reduction, etc.

The remaining functions devolving upon the Department Ordnance Office are so closely interwoven with the activities of the Hawaiian Ordnance Depot that absolute separation is impossible. Since the personnel of the two offices is so nearly identical, one system of administration is adequate. Records of civilian employees of both offices are kept under one head, as Civil Service regulations for both are practically the same. The mail and record section functions for both, as does the typing and stenographic force. Although, theoretically, all funds are allotted the Department Ordnance Officer and by him are sub-allotted as desired, it is deemed unnecessary to keep the finances of the two offices separately. Accordingly, all funds pertaining to both are carried by the Hawaiian Ordnance Depot and are accounted for by that office. Finance and purchasing sections thus come directly under the depot.

Since its organization in 1913, the Hawaiian Ordnance Depot has constantly increased in size and activity. The original depot consisted of one small storehouse at Fort Kamehameha, which carried a meager and far from satisfactory supply of ordnance. However, no suitable location for an ordnance establishment was secured until 1917 when the present site was obtained and occupied. Since

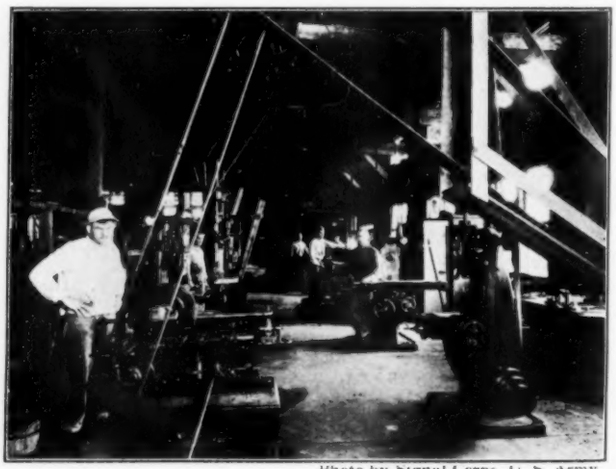


Photo by Signal Corps, U. S. Army

Ordnance Machine Shop, Schofield Barracks, Hawaii

that time the expansion of the depot has been remarkable, buildings and facilities being added rapidly, until at the present time a large and well organized institution, capable of carrying on all activities pertaining to supply and maintenance in Hawaii, is functioning. The present depot consists of forty-three buildings located on a reservation of approximately seventy-two acres. The entire area, with the exception of a section being developed at this time, is well lighted, has an excellent water and sewerage system, is equipped with an automatic sprinkler system—indeed, is modern in every way. An adequate railroad system has been installed so that cars may be loaded and unloaded directly at the storehouses. This facility, with the motor transportation at hand, excellently cares for the transporting of supplies and stores. Adequate protection has been provided. The reservation is surrounded by a seven-foot woven wire fence, topped by barbed wire and patrolmen guard all areas constantly.

The primary duty of the depot is the supply of the troops in the department and every effort is made to meet efficiently the demands of the using services. The question of supply depends first of all upon receiving material from the issuing establishments. Due to its great distance from the source of supply, the difficulties met with in the Hawaiian Ordnance Depot are greater than those in mainland depots. Receipt, after requisitioning, generally takes from six months to a year, so that the needs of the department must be anticipated for at least that period. Transportation from the mainland is uncertain, shipments leaving the issuing arsenals intact often arriving in Hawaii on three or four transports over a period of as many months. This condition is overcome to an extent by a rigid system of "follow-up" with all shipments overdue and by letters requesting expedition of delivery of supplies urgently needed. However, it is felt that some improvement may still be made to decrease the time required for transporting supplies from the mainland and to insure that shipments arrive intact.

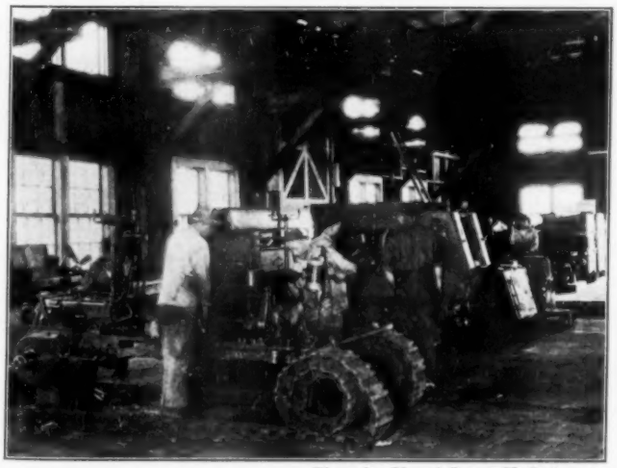


Photo by Signal Corps, U. S. Army

The Tractor Repair Shop, Schofield Barracks, Hawaii

The property division of the depot is divided into five working sections—property accounting, ordnance provisioning, storehouse and magazine, utilities and miscellaneous property. The last two sections named have no connection with the supply of the department but are concerned only with the depot property needed in the machine shop, carpenter shop, the 74th Ordnance Company and the various other activities of the depot.

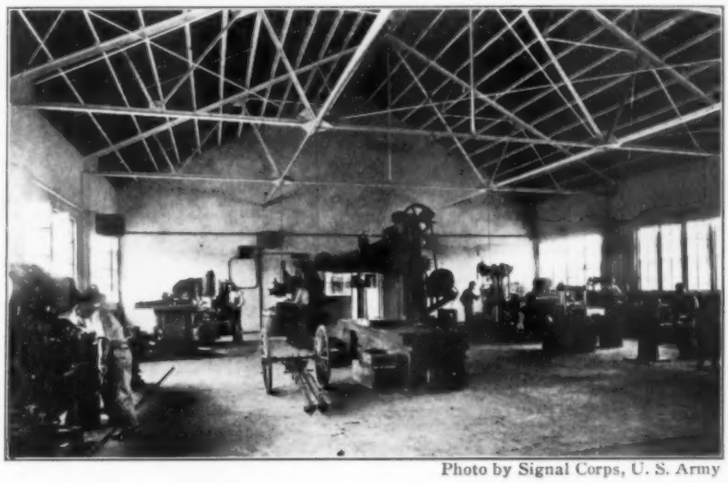


Photo by Signal Corps, U. S. Army

Another View of Well Equipped Machine Shop, Hawaiian Ordnance Depot

Direct supply of the organizations of the department is by the responsible post ordnance officers, to whom are charged the responsibility of anticipating, requisitioning, and issuing their needs. Transactions at the Hawaiian Ordnance Depot, then, are solely with the post ordnance officers concerned.

Although reserve stocks are handled and accounted for by the personnel responsible for current issue stores, they are kept physically separated. Independent storage places are provided insofar as possible, and, in any case, placards are placed conspicuously showing that the material stored is in reserve. Separate stock cards are kept and a distinct system of requisitioning, storing, and shipping is used. The handling, care, and preservation of reserve supplies presents one of the biggest problems of this department.

Personnel necessary in the supply of the department is furnished from the 74th Ordnance Company (Depot), with headquarters at the Hawaiian Ordnance Depot. The table of organization shows at a glance the distribution of the company and may also be taken as a guide as to the volume of labor at the different posts.

Those men at the depot function as a depot company, while the detached service men operate in much the same way as under the old ordnance detachment system. All members of the command are utilized solely in receiving, storing, and issuing property, except at the depot itself, where the necessity of caring for the police and guard of the post, in addition to the supply activities, is apparent.

Practically the entire work of handling both current issue and reserve matériel stored at or passed through the depot is handled by the company. Members have assisted in the development and assembly of ammunition during the past year. Specialists, such as stock record

clerks, checkers, packers, chauffeurs, painters, etc., assist in the accounting and caring for the matériel. Upkeep and care of motor transportation, stables, and animal-drawn transportation and grounds are also duties of the company.

The present system of guarding the depot has resulted in an appreciable saving in man-hours. Hardinge watchman clocks are carried by the patrolmen, who walk their posts by four hour tours. Since the adoption of this system sixteen men are able to guard the depot as efficiently as twenty-two under the old two hour system.

Photo by Signal Corps, U. S. Army

Assembling Smoke Shell in Hawaii

The military training, required by regulations, is given. All members are given record practice with the caliber .30 rifle.

At present work is under way on the assembly of thousands of 75-mm. chemical shell. Special equipment has been improvised and installed, the necessary jigs have been manufactured, and other necessary arrangements have been made to carry on the work, though handicapped by lack of matériel and experienced labor.

Maintenance

Maintenance has assumed such large proportions in the Hawaiian Department that the task has been divided into two sections, the matériel of the posts nearest Honolulu being cared for by the Honolulu Sector Shops and that of Schofield Barracks (Hawaiian Division) being looked after by the Schofield Sector Shops. It has been found that this division not only lessens the cost of transportation between organizations and the shops, but also greatly facilitates repair.

The Honolulu Sector, being widely dispersed, is provided with three shops, each with its own corps of machinists and each responsible for the maintenance of armament in its defenses.

The base shop, located at the Hawaiian Ordnance Depot, has by far the best equipped machine shop of the Army in Hawaii. Here may be performed any of the finer machine operations required in the repair of precise instruments of fire control, as well as the larger operations.

The blacksmith shop has a splendid outlay of tools.

An optical shop has also been installed, in which the fire control equipment of the entire department is maintained. Time interval recorders have been rebuilt in large numbers, difficult repairs to antiaircraft fire control matériel have been effected, field glasses are continually being reconditioned. While this section of the shop is its youngest member, it is considered one of the most important.

A well appointed tractor repair shop is another section. Here are performed all repairs necessary in the upkeep of artillery tractors at Fort Shafter and in the reserve of the depot.

In addition to the strictly machine sections, well equipped carpenter and paint shops are operating.

To the base shop is charged the upkeep of the 64th Artillery (3-inch antiaircraft mobile artillery) and of the 1st Battalion 55th Artillery (155-mm. G. P. F.), which are located at Fort Shafter. The gun park of this post being adjacent to the depot reservation, it has not been considered an economical policy to establish a repair shop at Fort Shafter. However, should there be an increase in the artillery stationed there, a shop may be necessitated.

Overflow work of any description from all posts is taken care of in the base shop. This at times is considerable, especially from the Artillery Brigade of the Hawaiian Division. The work of assembling the units received for the reserve is performed by machine shop personnel. During the past year, the time required in this activity has been considerable.

Research work and experimental activities are carried on in the base shop. The actual work of modifying the 240-mm. howitzer carriages for all around fire and of installing the quick release traversing mechanism was performed there. An attachment for mounting 37-mm. and 155-mm. G. P. F. guns for sub-caliber was designed and manufactured. A new type drill projectile, which successfully eliminates the sticking encountered with the present type, was perfected and tested in service. Experiments have been carried out upon matériel in service looking toward the correction of defects of design, etc.

In addition to activities relating primarily to armament, special jigs, devices, etc., are very often designed and made in the shop for unloading ammunition, fuzes and grenades, and for modernizing bombs and ammunition. Experiments in connection with matériel of other branches are conducted, especially that of the Chemical Warfare Service and the Air Service.

Work of an electrical or mechanical nature pertaining to post facilities is also taken care of, such as the maintenance of railroad trackage and rolling stock, major repairs to motor transportation, upkeep of buildings, lighting systems, automatic sprinkler systems, ground systems, and other facilities usually found on Ordnance Department reservations.

Each of the two coast defenses has its sub-base shop which is responsible for the care and upkeep of its matériel. The Coast Defenses of Honolulu are served by the shop at Fort Ruger and the Coast Defenses of Pearl Harbor by the shop at Fort Kamehameha.

The matériel to be cared for by the sub-base shop at Fort Ruger consists of the mortar matériel of Batteries

Birkhimer and Harlow, the 155-mm. gun matériel of the 2d Battalion, 55th Artillery, and the antiaircraft guns; gun matériel of Batteries Randolph and Dudley, and antiaircraft guns at Fort DeRussy; and the gun matériel of Battery Tiernon at Fort Armstrong. During the past year one gun of Battery Randolph was dismounted and a new relined gun mounted in its place. Work of adding drainage facilities to antiaircraft fixed mounts has recently been completed.

To the sub-base shop at Fort Kamehameha is allotted the mortar matériel of Battery Hasbrouck, the gun matériel of Batteries Closson and Selfridge, the gun matériel of Battery Jackson, the gun matériel of Batteries Chandler and Hawkins, the mortar matériel of the 41st Railway Battalion, the gun matériel of 3rd Battalion, 55th Artillery, the antiaircraft guns of both Fort Kamehameha and Luke Field, and the gun matériel of Battery Williston at Fort Weaver.

One of the greatest accomplishments of the past year was the erection and emplacing of Fort Weaver. While the larger portion of the labor was performed by ordnance machinists sent from the mainland and by the force assigned to this work by the Engineers, various drains upon equipment and personnel of the shop were necessary which proved to be an additional burden on our routine force. These guns have now been proof-fired successfully.

Each of the sub-base shops is in charge of a resident machinist who has the supervision of the armament in his coast defense. Each has its tractor repairman who is utilized solely in the upkeep of tractor matériel. He proceeds with the battalion for maneuvers, remains with it while on the march and in camp so that expert repair is provided at all times.

One machinist is allotted the 41st Railway Battalion since a great amount of labor is connected with its maintenance. He accompanies the battalion when maneuvering. In addition, the facilities of the shops in whose sections the maneuvers are held are provided for any emergency repairs which are necessary.

On account of the large number of modification work orders received it has often proved imperative to supplement the personnel of the sub-shops by sending out machinists from the base shop for the modification. However, this is invariably a temporary arrangement, and the machinist returns to his station as soon as the work is completed.

During the target practice season of the 64th Artillery, when the regiment conducts its firing in the coast defense posts, one machinist of the Hawaiian Ordnance Depot accompanies it and remains with it while firing, thus relieving the coast defense personnel for their own work.

The maintenance problem of the Schofield Sector is not only one of mobile matériel but also of the vast amount of reserve matériel that must be preserved. Until recently, but little effort had been made to establish the degree of maintenance in this sector that had been attained in the Honolulu Sector. Housing facilities for civilian personnel have always been very meager and the equipment provided is inadequate. However, a civilian corps has slowly been added as quarters have become available and equipment and tools collected as far as possible, so that in the very near future a much improved maintenance program is assured. A new building, constructed especially for ordnance activities, has been completed and equipment for the same has been promised. This will considerably increase the output possible in the old shop and, it is believed, will make the upkeep at Schofield independent of any other post.

To facilitate the repair of motor vehicles in the Artillery Brigade, small shops have been established in each of the three regiments. A civilian tractor repairman has been placed in each of the shops, who has supervision of the repair of tractors in the regiment and of the training of military personnel in the care and operation. It is planned to add to the equipment of these shops, as funds become available, with the aim to provide facilities for the upkeep of each regiment within the regiment by ordnance personnel.

In addition to the civilian personnel of Schofield Barracks, the 11th Ordnance Company (Maintenance), is provided, an organization special to the Hawaiian Department. This company is responsible for maintenance alone, storing and issuing of property being performed by the 74th Ordnance Company (Depot) detachment stationed there.

The entire company, with the exception of those required in routine duties of the company proper, are utilized in the maintenance program at Schofield Barracks. Many specialists are provided, including mechanics, machinists, tractor men, armorers, etc., who perform the actual maintenance under the supervision of the Division Ordnance Officer and his assistant who is in charge of the shop. Ten enlisted men are assigned to each of the maintenance shops of the Artillery Brigade to provide skilled labor in the maintenance of these regiments.

The upkeep of the mass of reserve supplies at Schofield Barracks presents a large problem. Great effort has been made recently to provide covered storage for all the reserve, and this has necessitated a great amount of labor. Thousands of shell have been overhauled and stored, approximately one hundred tractors were completely overhauled for permanent storage; tanks in the reserve were overhauled, and several thousand rifles and pistols have been placed in condition.

One phase of the maintenance problem in Hawaii should not be overlooked. Due to the even climatic conditions, outdoor drill is possible during the entire year. Consequently, periodic overhaul, as is possible in mainland posts, is not practicable. Maximum efforts are constantly required in order that matériel may not deteriorate. If this fact is borne in mind, it will be seen that a larger program is necessary than in posts where the indoor season may be utilized in bringing the matériel back to serviceable condition.

Of the Ordnance Officers assigned to this department, five are stationed at the Hawaiian Ordnance Depot and three at Schofield Barracks.

In conclusion, it may be stated that a continuation of the splendid efforts displayed by all the commissioned, enlisted, and civilian personnel assigned to assist the writer in the many ordnance functions of this department, will soon result in the attainment of that state of efficiency which is desired by the Chief of Ordnance.

Maintenance of Ordnance at Schofield Barracks

Ordnance at Schofield Barracks Hawaii

By

MAJ. JAMES KIRK, ORD. DEPT., U. S. A.

SCHOFIELD BARRACKS, Territory of Hawaii, is located near the center of the Island of Oahu, on a plateau with an approximate elevation of 1,000 feet. The climate is not hot, as one might expect at a tropical post, but is pleasant the year round, the temperature seldom rising above 85 degrees in the shade for midday summer heat and rarely falling as low as 50 degrees on the coldest night. Blankets are required for comfortable sleeping the year round. There is a rainy season of about two months, but this is not as terrible as its name suggests, for showers are generally of short duration and the days of fair weather outnumber the inclement ones even during this season. There are many localities in the United States which have far more unpleasant seasons.

Training is in progress the year round. As the entire Hawaiian Division with its specially augmented Field Artillery Brigade is stationed at Schofield Barracks, this garrison represents the largest grouping of troops in the United States Army. All arms of the service are represented by active organizations—Infantry, Tanks, Artillery, Air Service, Chemical War Service, Signal Corps, Medical Corps, Engineers, Quartermaster Corps and Ordnance Department. All are kept in active training ready to take the field.

The work of the Ordnance Department at Schofield Barracks may be classified under three main heads—Technical, Supply, and Storage. The force to carry on the work includes the Division Ordnance Officer who is on the staff of the Commanding General and is responsible for the proper functioning and coördination of all post and divisional Ordnance activities. An assistant to the Division Ordnance Officer acts as Maintenance Officer and is directly in charge of the Post Ordnance Shop. The 11th Ordnance Company mans the post ordnance shop and the mobile shop which maintains artillery repair truck detachments with each of the three Artillery Regiments and a repair section on the small arms firing range. Supply is maintained by a small detachment of the 74th Ordnance Company under the Post Ordnance Supply Officer. An assistant to the Supply Officer is immediately in charge of the war reserve storage, having under him a detail from the 74th Ordnance Company.

Storage

Starting in reverse and beginning with storage, this particular activity is generally overlooked due to the popular conception of the term which seems to be that all that need be done is to put things in a warehouse, lock the door, and forget about them. This rather general belief is unfortunate, for it is difficult to obtain adequate personnel and warehousing facilities. Shipments arrive in miscellaneous lots and boxes, which must often be repacked if storage is to be in order, so that when an article is wanted it can be found. Artillery, small arms and motor vehicles require percentage inspections and overhaul. Ammunition needs constant surveillance and, due

to frequent regrading, is in a state of continual turnover. As the space occupied by ordnance storage at Schofield includes some forty-five buildings scattered over a stretch of four miles quite a little energy must be expended on this activity, especially as the major portion of the stores is ammunition. The present force for handling this branch of work consists of one special duty officer, one technical sergeant, one sergeant, one corporal, three privates of Ordnance and fatigue details of line troops. The Ordnance personnel takes care of the supervision, necessary paper work, inspections, and interior police of buildings under the immediate direction of the officer in charge. Maintenance work on stored material is handled by the personnel of the 11th Ordnance Company, and is in addition to divisional maintenance. During the past year 80 tractors have been completely overhauled, 100 75-mm. guns and carriages conditioned, 5 155-mm. howitzers and carriages completely overhauled, 1,000 rifles and 12,000 pistols given a thorough shop inspection and regular percentage inspection made on 155-mm. guns, 240-mm. howitzers, antiaircraft trailers, trucks, reels, caissons, machine guns and numerous other items of Ordnance matériel. Most of this matériel was received and stored within the past two years. A great deal of necessary paper work has been entailed in bringing stock record cards up to date. The nomenclature of items stored has been changed due to revisions and publication of standard nomenclature lists, and all records have been revised to accord with these as far as possible. The absolute necessity of care in preparing shipping tickets becomes very apparent when thousands of items must be classified for storage. This classification becomes very difficult when different names are given to like articles on different records.

Ammunition surveillance requires constant attention. Millions of rounds of small arms ammunition are separated into several hundred lots and these are carefully checked monthly as to grade so that those lots least suitable for storage are issued first. Some ninety powder samples of artillery ammunition are kept in test bottles which are inspected at each daily inspection of magazines. During the past year some 10,000 155-mm. shell have been handled for alteration of the rotating band alone. Approximately 60,000 75-mm. shell were moved for assembly into complete rounds, and thousands of shell have been inspected for exudation. Approximately 200 carloads of ammunition received on transports have been stored.

Supply

Supply includes both post and divisional activities. In time of peace and under the situation existing in Oahu the two are so closely related that no attempt at differentiation will be made. The customary paper transactions are in vogue. The unit commander presents his requisitions for the regiment. Expendable supplies and non-expendable supplies are listed on separate requisitions. These requisitions are examined and approved by the regimental commander who forwards them to the Division Ordnance Officer. Here they are checked as to correctness of form and authorized allowances. If correct the amount authorized to be issued is indicated, the requisition is approved and sent to the Ordnance Issue Warehouse. Non-expendable supplies are issued on shipping ticket and expendable supplies use the requisition as a voucher. Articles not immediately available from stock are held on back order for thirty days, after which time if issue has not been made the requisition is cancelled and items still needed must be incorporated in a new requisition. This last step is not desirable but has been found necessary as organizations invariably duplicate requests if back orders are held open too long. On a small post this could be watched closely, but it presents an immense amount of work where a large number of organizations are involved.

Ammunition requisitions are most common and these have always been filled. Other requisitions generally represent loss of equipment or some demand for new equipment required by newly published orders or change in strength. The "Exchange System" has greatly reduced the number of requisitions received from organizations. Under this system an article or part that has become broken or worn out through fair wear and tear in the public service can be presented for exchange when accompanied by the proper certificate of cause. To prevent waste a little red tape has been added to this procedure which requires all articles of value to be routed through the ordnance shop for inspection before the exchange is approved. As the shop is adjacent to the warehouse this causes little delay, and in many cases repairs can be made on the spot and any exchange becomes unnecessary.

Under the former system of periodic requisitions the ordnance warehouse was merely a clearing house. Articles were requisitioned in advance of actual needs, and upon receipt were promptly issued to the organization so that with the exception of a few emergency supplies no stock was maintained. Under the present system it is absolutely imperative to maintain an ample stock. As data for many items are not obtainable from old allowance tables, figures must be obtained from experience during the past two years. The supply must be automatic so that six months has been fixed as a maximum, and three months as a minimum. Several thousand stock record cards are involved. On each card the minimum figure is entered in red ink and the maximum in black ink. In many cases the figures are the same. Requisitions on the Hawaiian Ordnance Depot are submitted monthly for certain groups so that the elapsed time between requisitions in the same group is three months. In each case supplies are requested to bring the stock to the maximum. As more than a month is generally required before the requisition is filled the maximum is very seldom reached. Occasionally emergency or special requisitions are necessary. To date the greatest difficulty has been experienced in building up an initial stock. This is now well under way, and the "Exchange System" is, on the whole, working satisfactorily. It is perhaps appropriate to remark that much more intricate storage is required than formerly. Supplies must be stored according to group and small articles must be kept in properly tagged bins. At Schofield, thousands of bins have been constructed of salvaged ammunition boxes with satisfactory results and but little cost. The warehouse is neat, orderly, and any article can be located readily. A running inventory by groups is maintained. Worn out items turned in are kept listed separately and are periodically salvaged after in-

spection, so that the stock record cards represent a true balance of serviceable stores.

Including ammunition the Ordnance supplies issued to troops at Schofield Barracks during the past year had a valuation of more than one million dollars. This includes National Guard and R. O. T. C. encampments and Department competitions.

Technical

As a matter of fact, all Ordnance activities could very well be grouped under the caption of "Technical," but I have chosen to group under this head the advisory, inspections, and repair functions.

The Division Ordnance Officer is on the Staff of the Commanding General and works directly under the G-4 Section of the General Staff, but he must maintain close contact with all staff officers, with the regimental commanders and with the commanders of lower units. If a letter is to be prepared on an ordnance matter the original draft is prepared by him. This requires accurate and current knowledge on the subject in hand. Field Service Bulletins and the monthly copy of "The Ordnance Digest" are valuable sources of information, and a file of pamphlets, equipment charts, and hand books must be available. Questions as to ammunition, equipment, functioning of arms, weights, volumes, fuel consumption of motor vehicles, speeds, tractor power, safety and operation are continually arising and the Ordnance Officer must be able to give, or at least to obtain, the information desired. Knowledge of how guns and recuperators operate, how tractors and trucks operate, what different tools can be used for, what action may be expected from ammunition, how range tables are used, and many other questions that continually come up, especially when present at a "Maneuver" or "Test." These are merely cited to illustrate that there are many side issues that require time and very often study outside of the routine job of handling requisitions and surveys. In a unit as large as a Division an Ordnance Annex must generally be prepared for the Division Order whenever a maneuver occurs. As maneuvers are of rather frequent occurrence considerable time is spent on this work. The usual report on status of work orders, the annual report on principal ordnance stores and many others must of course be prepared and forwarded.

At least once a year all ordnance material in the hands of troops and in storage must be given a technical inspection. The material in storage is given a general inspection monthly. The technical inspection of storage material consists in the selection of certain items, according to percentages laid down in Field Service Bulletins, and in giving them a thorough shop inspection. If conditions are found good this suffices, but if evidence of rust or other deterioration is found a thorough inspection of thousands of items is made, and steps taken to apply a remedy. Information tabulated during the shop overhaul of major items from organizations helps on the inspection of material in the hands of the troops, but in addition it has been found necessary to go over artillery material and small arms in a great deal of detail. This work is done by the Division Ordnance Officer assisted by the civilian foreman machinist and one or two mechanics. In the inspection of the Artillery Brigade all tractors are operated when possible, and all other vehicles and guns thoroughly checked. The compilation of the reports after an inspection has been found to be a big job but exceedingly valuable towards obtaining information as to needed repairs and supplies. Firing as many rounds as they do under present allowances for target practice, unit school instruction and competitions, small arms are continually wearing out. Where the accuracy of the weapon is in question, it is targeted in accordance with existing regulations after proper certificates are furnished and inspected before replacement is authorized. Last year approximately seven million rounds of .30 caliber and one and one-half million rounds of .45 caliber ammunition were fired.

Ordnance maintenance has been made an active factor in the Hawaiian Division. There is a well equipped base shop with an Ordnance Officer, experienced in shop work, in charge. Under him is a civilian foreman machinist with several civilian mechanics as assistants. Although the bulk of work is handled by members of the 11th Ordnance Company, the civilians are necessary to handle the jobs requiring the greatest skill and to instruct the enlisted men. Many men with a high degree of skill are developed among the enlisted men, but the turn-over due to the "Expiration of Foreign Service Duty" is so great that a permanent force of skilled men is absolutely necessary to act as an operating and training nucleus. All classes of Ordnance overhaul and repair are handled in this shop in large volume. Tractors, trucks, 155-mm. howitzers, reels, carts, 75-mm. guns, 37-mm. guns, trailers, machine guns, automatic rifles, rifles, pistols, and countless other smaller items are under continual overhaul. The war reserve overhaul mentioned above is in addition to this current work.

Machine work, welding, blacksmithing, tool making, electrical repair and many other shop operations are necessarily carried on.

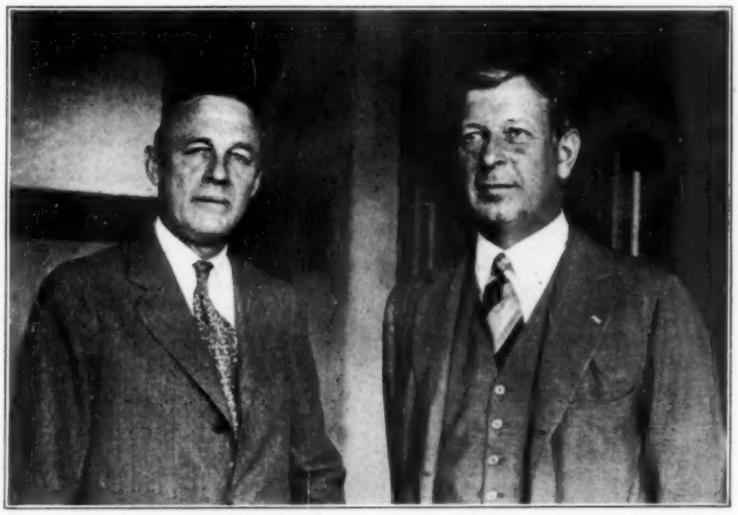
In addition to the base shop three detachments of ten men and one civilian tractor mechanic each, are maintaned with the 11th Field Artillery Brigade. The three regiments of this brigade operate over the entire Island. With each detachment is one artillery repair truck. These detachments accompany the regiments when they go into the field and operate in the regimental parks when the regiments are in garrison. They have proved of great utility in regulating the replacement of worn parts and in making repairs not requiring heavy machine shop work. Both the base shop and the mobile shop are kept continually busy. The endeavor to do only satisfactory work has in a large measure been achieved and the Ordnance shops are relied upon with confidence by all branches of the service at this station.

It may be appropriate, in closing, to comment on the greatest difficulty encountered. This can be summed up in one phrase, "War Reserve." Subtract the War Reserve Storage from Ordnance activities and everything would run smoothly, but with the immense project in actual existence the present force is not adequate. A headquarters platoon of an ammunition company has been recommended as a suitable unit to operate the sub-depot. When it is furnished the Ordnance organization can function smoothly in the Division at Schofield Barracks.

Industrial Preparedness Advocates Honored

Certificates Conferred at Army Industrial College Graduation Exercises

CERTIFICATES of appointment as honorary advisor to the Army Industrial College in recognition of notable service to the national security through Industrial Preparedness were conferred upon fourteen distinguished civilians by Hon. Dwight F. Davis, Acting Secretary of War, at the graduation exercises of the third class of the College, Washington, D.C., June 30, 1925. Those to whom certificates were awarded were:



Hon. Benedict Crowell, President Army Ordnance Association, and former Assistant Secretary of War, with Col. Dwight F. Davis, Acting Secretary of War, at Graduation Exercises, Army Industrial College, June 30, 1925.

BERNARD MANNES BARUCH, New York City. Chairman, War Industries Board, 1918; Member, Advisory Commission, Council of National Defense.

ROBERT SOMERS BROOKING, St. Louis, Mo. Member, War Industries Board, 1917, Chairman of Price Fixing Commission during World War; President, Board of Trustees, Washington University, St. Louis, Mo.; President, Institute of Economics and Institute for Government Research, both of Washington, D. C.

BRIG. GEN. JOHN J. CARTY, Auxiliary Reserves, New York City. Assistant to Chief Signal Officer, A. E. F., during the World War; Chairman, Board, American Telephone and Telegraph Co.

HON. BENEDICT CROWELL, Cleveland, Ohio. Assistant Secretary of War, 1917-20. President, Army Ordnance Association since its establishment, 1919; Chairman of the Board, Crowell & Little Construction Co., Cleveland, Ohio.

HON. CHARLES G. DAWES, Vice-President, United States of America; Chief Purchasing Agent, A. E. F.

SAMUEL MORSE FELTON, Chicago, Ill. Director General of Military Railways, 1917; President, Chicago Great Western Railway.

JUDGE ELBERT HENRY GARY, New York City. Chairman, Advisory Committee, New York Ordnance District; Chairman of the Board, U. S. Steel Corporation, and President American Iron and Steel Institute.

WALTER SHERMAN GIFFORD, New York City. Director, Council of National Defense, 1916-18; Supervising Director, Committee on Industrial Preparedness, Naval Consulting Board, 1916; U. S. Representative on Inter-Allied Munitions Council, 1918; President, American Telephone and Telegraph Co.

WILLIAM GREEN, Washington, D. C. President, American Federation of Labor.

ALEXANDER LEGGE, Chicago, Ill. Vice-Chairman, War Industries Board; Manager, Allied Purchasing Commission; President, International Harvester Co.

DR. FRANKLIN H. MARTIN, Chicago, Ill. Member, Advisory Commission, Council of National Defense, 1916-21; Director General of the American College of Surgeons.

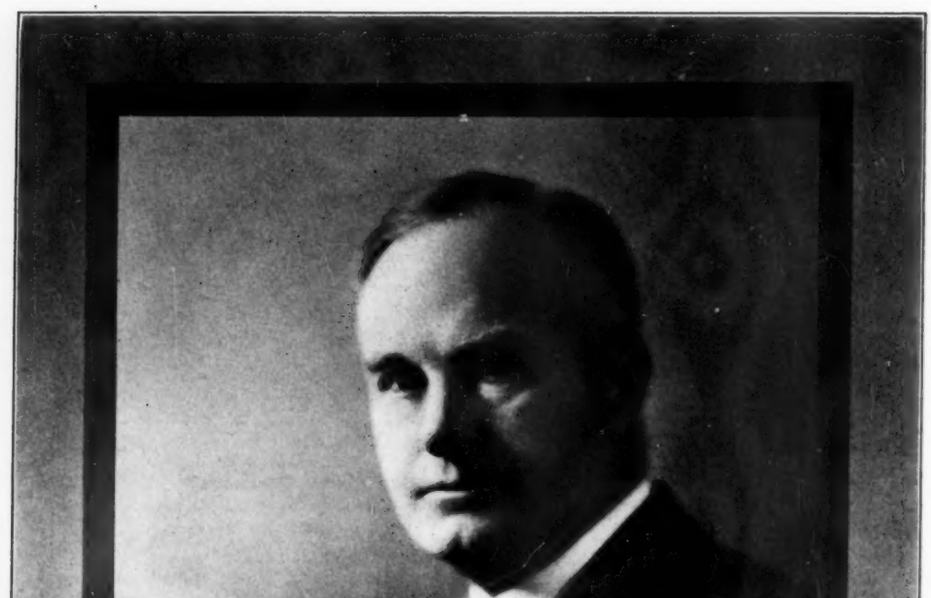
COL. FRANK AUGUSTUS SCOTT, Ord. Res., Cleveland, Ohio. Chairman of the General Munitions Board and First Chairman, War Industries Board; Chief of the Cleveland Ordnance District, and a Director of the Army Ordnance Association since 1919; President, Warner & Swasey Co., Cleveland, Ohio.

GEN. GUY E. TRIPP, Ord. Res., New York City. Chief, Production Division, Ordnance Department, 1918; Director of Army Ordnance Association since 1919 and President of New York Post, A. O. A.; Chairman of the Board, Westinghouse Electric and Manufacturing Co.

DANIEL WILLARD, Baltimore, Md. Member, Advisory Commission, Council of National Defense, 1916; Chairman, War Industries Board for a period; President, Baltimore & Ohio Railroad.

The principal address to the twenty-six officers who comprised the third class of graduates of the Army Industrial College was delivered by Brig. Gen. J. J. Carty. General Carty rendered conspicuous service during the World War and has since been actively interested in the problem of industrial preparedness.

The following officers were graduated: Capt. Elliot Snow, C. C., U. S. N.; Capt. J. R. Defrees, U. S. N.; Col. W. A. Dempsey, Q. M., Res.; Lt. Cols. C. C. Whitcomb, M. C.; R. T. Ellis, Q. M. C.; C. E. Reese, Q. M. C.; and W. C. Baker, C. W. S.; Comdr. D. C. Cather, M. C., U. S. N.; Comdr. L. W. Jennings, Jr., S. C., U. S. N.; Majs. A. G. Gutensohn, S. C., Fred Seydel, C. W. S., C. A. Schimelfenig, O. D., I. A. Rader, A. S., S. W. Fitzgerald, A. S., D. B. Netherwood, A. S., D. C. Cordiner, Q. M. C., R. W. Riefkohl, Q. M. C., R. L. Maxwell, O. D., J. L. Frink, Q. M. C., and H. F. Cameron, C. E.; Capts. W. J. Henry, O. D., E. E. MacMorland, O. D., and S. E. Nortner, C. E.; Lieuts. C. W. Steinmetz, A. S., and H. W. Rowan, C. W. S.



COL. BRUCE CORNWALL, ORD. RES.

Chief, San Francisco Ordnance District

San Francisco Ordnance District

By

COL. BRUCE CORNWALL, ORD. RES.

IN 1917 and 1918 the Pacific Coast manufacturers did not contribute directly to the Ordnance program to any great extent, for a variety of reasons: the "market" was in France; and the transportation situation operated to hold production as near to the Atlantic seaboard as possible, especially where the raw or partly finished materials originated there; the shipbuilding program, of necessity confined to seaports, utilized the shipyards and the allied and available metal trades industries to their fullest capacity in the Pacific Coast ports; and, beyond that, our manufacturing facilities of 1917 were not so large or so varied as they are today. So this territory was a part of the St. Louis Ordnance District. But a few important contracts were placed here. The first of these was for the production of toluol, the base of TNT, by "cracking" crude oils or petroleum distillates. The pioneer in the work was the General Petroleum Company. It received a contract for a toluol extraction plant to cost $4,200,000 and to produce 2,000,000 gallons per year. At the time of the Armistice this plant had produced 88,000 gallons. The Standard Oil Company also received a contract to produce toluol by the same method. Together these companies had undertaken to install facilities and produce 7,000,000 gallons of toluol a year.

The second contractual activity was the utilization of kelp. In 1914 we were dependent on Germany for the potash required for black powder. Long before September, 1918, the Hercules Powder Company was extracting potash from Pacific Coast seaweed at the rate of 500 tons a month, and along with it furnishing other much needed chemicals. The kelp or seaweed from which these substances were taken grows along the shallow and rocky waters of the Califronia coast, and was cut by three great seagoing harvesting machines.

Other activities were the manufacture of TNT by the Hercules Powder Company and the Atlas Powder Company. The valuable work of the Holt Company in producing its military tractors is well known.

A unique and exceedingly valuable contribution was made by the Mt. Wilson Observatory in the grinding and polishing of lenses for optical instruments.

All of these agencies are potentially of great value today, and will be included in the war plans of this district.

The District, as at present organized, was established in 1923. It includes the States of Washington, Idaho, Oregon, California and Nevada. At present, and so far as the trend of industrial development now indicates, the Ordnance manufacturing operations in an emergency would be confined to three regions, first starting in the north, the region in and about Portland and Seattle; second, the San Francisco Bay region, and third, Los Angeles. From the Ordnance point of view, these are three distinct and separate communities, and industrially the connection between them is very slight. Their separation in time and distance is a distinct handicap to the operations of any organization covering the entire Pacific Coast. While the survey of facilities made and the allocations asked for have covered these three parts of the District the war orders placed so far have been confined to plants in and about San Francisco that can be frequently visited. Personal contact with the plant management has been found to be essential to secure any progress in the project after the initial survey and definite allocation have been made. It is expected to place allocations in the manufacturing centers of Los Angeles, Portland and Seattle in the future, so that the present situation is a temporary phase. To date more than 160 plants have been visited, and the necessary data concerning them made of record. In cases where it developed that the plant would be of little value to the Ordnance Department or to the War Department for manufacturing purposes only such data have been taken as would indicate the character of the plant.

From the manufacturing point of view there has been a steady growth and expansion of the kind of manufacturing facilities that are useful to the Ordnance Department, and the evidences of such expansion and growth are reflected in the records of the district. The essential resources for such continued development are clearly available. Ample supplies of raw material are at hand; iron ore, coal, copper, petroleum, cotton, metal alloys, etc. The hydro-electric development in the Sierras is more than sufficient to meet the present demands and brings cheap electric power to the bus bars of practically every manufacturing plant in the State. There is an abundance of water power, developed and undeveloped, available for future expansion. Transportation facilities in the manufacturing centers are excellent. In general there is a satisfactory supply of skilled labor, although the proportion of higher class machinists, including gage makers and tool makers, is no doubt low. The expansion of manufacturing facilities of the kind in which Ordnance is interested is subject to the laws of supply and demand in the markets of the world. Their growth depends upon the development of a market in which their products can compete successfully. The continued rapid growth of Pacific Coast population is developing a large local market. Export business to the Orient is another favorable outlet. If the industrial development of the Pacific Coast continues at the rate recorded during the last ten-year period its contribution to the Ordnance program will continue to increase in volume and value.

After all, distance is a big factor in our experience in spite of our cheap and almost instantaneous means of communication. Most of the industrial activities of the last war, even in this country, were thousands of miles away and humanly speaking the Pacific Coast had little or no contact with them. What this means is that we

find ourselves in about the same situation that the Ordnance Department would have faced in the middle West districts in 1905, or thereabouts, as regards the contact or experience of manufacturers with war time Ordnance manufacture. This makes our problems different. We are dealing largely with manufacturers or persons in the management of manufacturing plants who had no contact with Ordnance during the World War, and in the general case did no war work of any kind. This adds to the interest and possibly to the value of the work in this district. In a sense the district may be considered an experimental laboratory in which to test the fundamental soundness of the principles of industrial mobilization. If the condition of the public interest and knowledge, and by "public" is meant the manufacturing public, can be compared with that which existed in the East twenty years ago, it is also probable that it represents quite accurately the condition of public interest and knowledge towards which we always tend during a prolonged period of peace and which may reasonably be found again in the eastern manufacturing districts in another twenty years. If we can get in touch with the manufacturer with what may be called Main Street limitations and convince him of the necessity for carrying on in time of peace some such organization as we are working with, and if his outlook upon national and international affairs and his conviction as to his responsibilities under them lead him to lend us a degree of sympathy and support that will in the long run make effective and permanent such plans as we now have in mind, does it not argue well for ultimate success? Perhaps it is better evidence than can be obtained anywhere else or by any other method at this time.

Boston Post, A. O. A., Established

ANOTHER local post of the Army Ordnance Association can now be added to the already growing list of local activities of the A. O. A. The Boston Post was formed June 30th at a most enthusiastic meeting held in the Engineers Club, Boston. Maj. Gen. C. C. Williams, Chief of Ordnance, was present and congratulated the members upon the formation of this new local unit and extended hearty wishes for its success. The Association is now represented with local posts in New York, Chicago, San Francisco, and Boston.

At the Boston meeting the following officers were elected: President, Col. Edward F. Miller, Ord. Res.; Vice-President, Maj. M. T. Carney, Ord. Res.; Treasurer, Lt. Col. Jeremiah Campbell, Ord. Res.; and Secretary, Capt. L. P. Crim, Ord. Dept., U. S. A. The following were elected to the Board of Directors: Maj. F. A. Estes, Ord. Res.; Maj. M. M. Osborne, Ord. Res.; Maj. J. S. Smyser, Mr. Chas. H. Pearson, Mr. Chas. F. Cowdrey, and Mr. A. E. Barter.

The members present were most enthusiastic over the formation of this new local unit of the Army Ordnance Association and displayed a very satisfactory spirit of optimism for the future success of the Post. New England has always been in the forefront of industrial preparedness activities and this latest evidence of interest and co-operation augurs well for the future of ordnance activities in that section.

After the meeting adjourned, a number of those present contributed to a fund which was turned over to the United Services of New England to be expended for prizes in the Army Ordnance Association match at the tournament of the United Services to be held August 16 to 23, inclusive. This gift on the part of the members of the Boston Post was acknowledged by Maj. Gen. Walter E. Lombard, M. N. G., Retired, who extended an invitation to them to attend the tournament and witness the work being done by the United Services of New England in the development of rifle practice.

The office of the secretary of the Boston Post, Army Ordnance Association, will be at the Boston District Ordnance Office, Room 432, 200 Devonshire Street, Boston, Mass. All members of the national association who reside near Boston are urged to affiliate themselves with this new post.

The objectives of the Boston Post as set out in the Constitution adopted at the meeting are:

"To assist in effecting industrial preparedness for war as being one of the Nation's strongest guarantees of peace;

"To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

"To promote mutual understanding and to effect co-operation between American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

"To disseminate professional and technical information so that Reserve Ordnance Officers may be able to serve effectively with the armies in the field in time of war;

"To preserve the memory of the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged."

Article III of the Constitution provides that, "All members of the Army Ordnance Association residing in the Boston Ordnance District shall be eligible to membership in the Boston Post."

Members of the A. O. A. who are eligible for membership in the Boston Post are urged to affiliate themselves with this worthy enterprise.

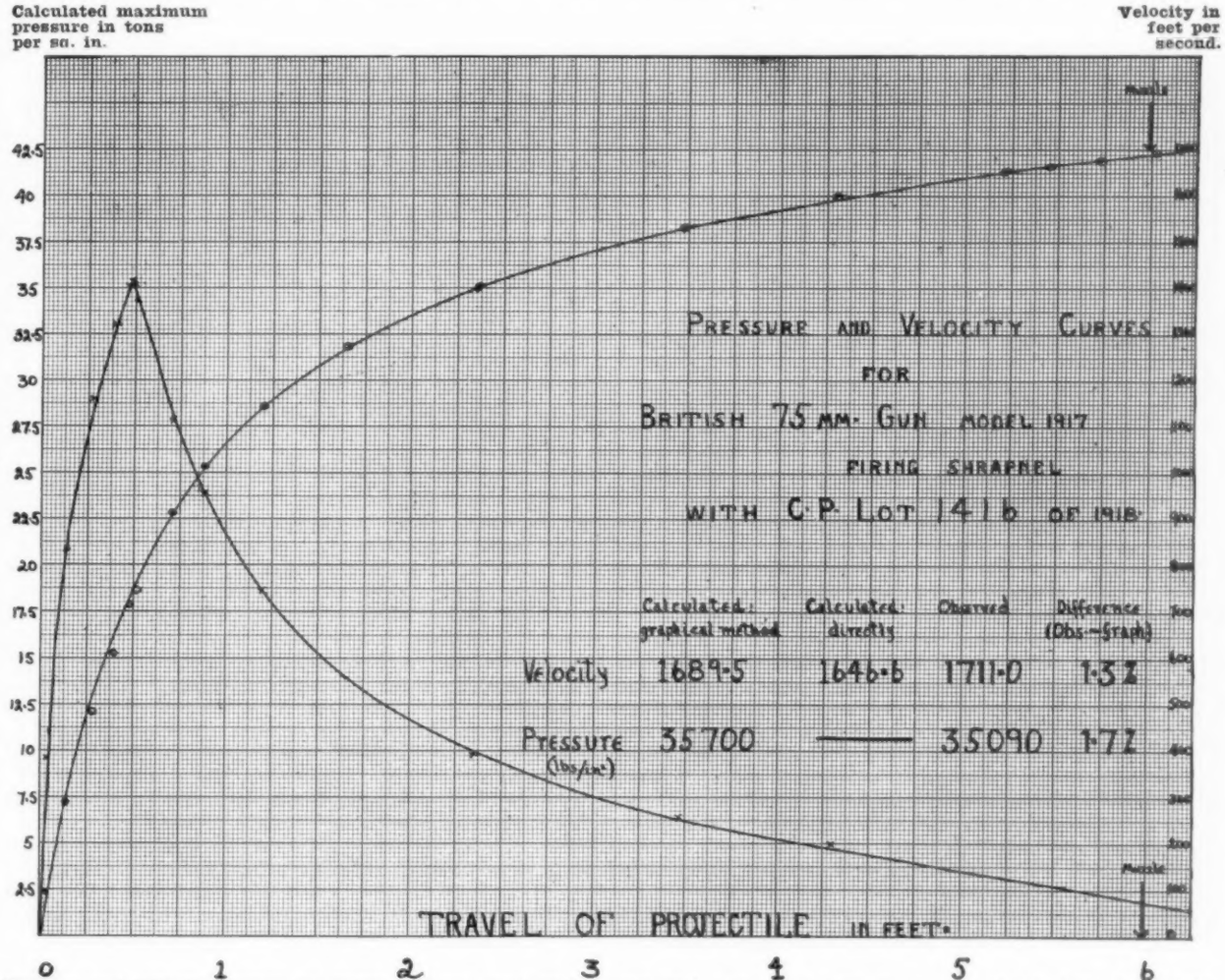
A Calculated Relation Between the Ballistics of the 75-mm. Gun and the Mean Web of the Powder

By

PROF. F. W. POWER, S. J.

THE work described in this article was done in the spring of 1919 while the writer was a member of the staff of the Inspection Division, Ordnance Department, at Carney's Point, N. J.; later it was communicated privately by him to some friends, and the results themselves sent to Colonel William S. Tschappat; but it was felt that it would be advisable to publish the calculations described and summarized here not because of any originality on the part of the writer, but simply for the sake of putting on record in ARMY ORDNANCE some interesting and, it is hoped, useful data concerning interior ballistics.

The calculations described in this paper give *first* an idea of the check which may be obtained between the observed and calculated ballistics of the British 75-mm. gun, the latter quantities being computed according to the method given in Tschappat's *"Ordnance and Gunnery"* (John Wiley, 1st ed. 1917); and *secondly*, a relation between the ballistics of this gun and the granulation of the powder from which they are calculated.



Pressure and Velocity Curves for British 75-mm. Gun, Model 1917, Firing Shrapnel with Cannon Powder Lot No. 1416, 1918

The powder taken as a basis is Carney's Point Lot 1416 of 1918, since the constants of this powder were very well established both in the laboratory and at the proving ground due to its use as a standard powder in the firing of the seasoning test at the Carney's Point range and elsewhere. The gun constants were taken from drawings for the 75-mm. gun, model 1917 (British) numbered 52-72-1 and 52-72-3, obtained through the courtesy of Lieutenant-Colonel C. J. Browne, who also gave the equation for the developed curve of the rifling:

$$y \text{ (inches)} = 0.01039\ x^{3/2} \text{ (inches)}$$

(whence $\tan \phi = 0.01558\ x^{1/2}$), and the information that the pressure required to start the projectile in the bore was 5,600 lbs. per square inch for the French 75. As nothing definite could be learned about this quantity for the British 75, this same figure was used in the present calculations. The chemical data for the powder were obtained in the Inspection Division's laboratory at Carney's Point Plant No. 3; the determinations were made according to the methods given in the Manual, except that the alcohol had to be determined by a pyknometer in lieu of a refractometer. A blank on an aqueous solution of diphenylamine at 20° showed that this substance which was carried over in the very weakly alcoholic distillate from the powder was not sufficiently soluble to affect the results within the limits of experimental error. The total volatile determination was run in tins. A typographical error in "equation 6" on page 117 of the first edition of Colonel Tschappat's book caused a good deal of trouble at first and was very hard to detect; but it finally appeared that the constant 875 in the denominator of this equation should read 87.5. A few errors were also noted in the tables giving the values for the characteristics of the powder grains and for $y' = f(z)$; that is, for the percent of the volume of the grain burned (y') as a function of the percent web burned (z). These characteristics were accordingly calculated independently. Using the ratios L/D (=y) and D/d (=x) for Lot 1416 throughout all the calculations this function comes out

$$y' = 0.71584\ z + 0.14615\ z^2 - 0.0126\ z^3.$$

After the methods of calculation had been worked out and it was seen how the figures would run, three powders were postulated whose x and y values were identical with those of the standard powder, but whose mean webs differed from one another by 0.001 inch. The calculations were then carried through for each one of these powders, giving finally the calculated difference in the ballistics due to a given difference in granulation. The calculation involves three main steps: *first,* computing the various constants; *secondly,* plotting and integrating the function $F(z) = \int \frac{z - z_o}{By' - (z - z_o)^2}$ where z_o is the percent web burned when the projectile starts to move and B is a constant depending for its value on the mean web of the powder; *thirdly,* computing the values of the pressures and velocities as functions of z, and hence as functions of the travel of the projectile. The most troublesome of these steps is the integration of F(z), which cannot be performed by any ordinary mathematical process inasmuch as y' is a function of z only until the formation of slivers; after which it is necessary to use values of z even greater than unity. The integration was accordingly performed by the mechanical process of weighing a known area of coördinate paper on an analytical balance and then weighing strips cut off at various values of z up to the curve of the function $\frac{z - z_o}{By' - (z - z_o)^2}$ This process gave a simple function of the travel of the projectile, and by making use of a "paper factor," the weight of the paper strip could be converted directly into the velocity of the projectile. In order to secure the desired degree of relative accuracy in velocity and in pressure for all four powders, it was found advisable to repeat the final stage of the calculations, beginning at the integration, for the "critical points" (near the muzzle and near the point of maximum pressure), using the same kind and size of paper for each one of the four powders, and to weigh the strips very close together—say at intervals of 0.02z. This permitted plotting the velocities and pressures as functions of the travel on a large scale at these "critical points," making it possible to read the muzzle velocities and maximum pressures very closely and with the same accuracy for all four powders. Of course the calculation of the muzzle velocity by itself could also be done by the one equation given by Tschappat for that purpose, but it was desired to get the form of the curves for Lot 1416, and it was not difficult to perform the same operations for the other "critical points" for the other powders, since the work was done on a Munroe calculating machine. When the velocity for Lot 1416 was actually computed at one operation by this formula (No. 116), the value 1646.6 feet per second was obtained, which is not nearly as good a check on the observed firings as was given by the graphical method.

The various quantities entering into the problem will now be enumerated, first those that are the same for all four powders, and then those which depend for their value on the mean web.

CONSTANTS WHICH ARE THE SAME FOR ALL THE POWDERS

Powder Constants

Charge	1.543 lbs.
Igniter	0.017 lbs.
Total	1.560 lbs.
Equiv. Smokeless	1.552 lbs.
D/d (x)	8.83
L/D (y)	3.01
Nitrogen	12.614%
Total Volatiles	3.57%
water (by diff.)	2.62%
alcohol	0.95%
Energy per pound of powder	1351675 ft. lbs.
Specific Rate of combustion	.0001818 in./sec.
Proportional part of vol. of grain burned when projectile starts to move (y'_o)	.0424
Proportional part of web burned when projectile starts to move (z_o)	.0585
Specific Heat ratio (C_p/C_v)	1.3
Ash	0.20%
Diphenylamine	0.49%
Specific Gravity	1.52

Gun, Projectile, and General Constants

Vol. of cartridge case	85.5 in.^{3}	Mean effective pressure to muzzle	18437 lbs.
Area of cross-section of gun	6.835 in.^{2}	Actual weight of projectile	15.96 lbs.
Reduced length of cartridge case	0.70 ft.	Travel of projectile in gun	5.99 ft.
Average tan ϕ	0.0664	Weight of gun and recoiling parts	1003 lbs.
Weight of projectile (reduced)	16.80 lbs.	Ratio of velocity of recoil to velocity of projectile	0.0167
Pressure required to start projectile	5600 lbs.	Temperature of charge	59°F.
Mean value of passive resistance throughout bore	3700 lbs.	"Travel factor"	2.411
		Loading density	0.503

Constants Which Are Different for Each Powder

Powder	Lot 1416	No. 1	No. 2	No. 3
L	0.3928	0.3829	0.4012	0.4193
D	.1305	.1272	.1333	.1393
d	.0148	.0144	.0151	.0158
MW	.0215	.0210	.0220	.0230
R(=½MW)	0.01075	.0105	.0110	.0115
"B"	12.981	13.606	12.397	11.343
"H"	786.6	768.3	804.9	841.5
"G"	.7133	6806	7469	8164
Velocity factor	655.1	639.9	670.4	700.8

Any discrepancies in the agreement of the MW with x and y are due to the fact that more than four places were carried in the calculation of these values, but only the nearest four appear in the table.

In the following tables the calculations are given in full for Lot 1416, but only the critical values for the other powders.

Calculation of Velocity and Pressure for Lot 1416

x		0.20	.50	.80	1.00	1.13	1.14	1.15
$x - x_o$		0.1415	0.4415	0.7415	.9415	1.0715	1.0815	1.0915
$(x - x_o)^2$		0.02002	0.19492	0.54982	.88642	1.1418	1.1696	1.1914
y'		0.1490	0.3929	.6598	.8494	.9773	.9873	.9973
By'		1.93417	5.10024	8.56486	11.0261	12.6859	12.8157	12.9456
$By' - (x - x_o)^2$		1.9142	4.9053	8.0150	10.1396	11.5441	11.6461	11.7542
$\frac{x - x_o}{By' - (x - x_o)^2}$		0.0739	0.0900	.0925	.0929	.....	.....	.0929
$\log \frac{u - l_o}{l_o}$		0.01835	0.07999	.14700	.19247	.22414	.....	.22837
$\frac{u - l_o}{l_o}$		1.04	1.20	1.40	1.56	1.676	.....	1.693
$u - l_o$		0.73	0.84	.98	1.09	1.173	1.179	1.185
u		0.03	0.14	.28	.39	.473	.....	.485
V		93	289	486	617	.....	.....	715
P		18610	41450	58050	66030	70210	70460	70750
x		1.16	1.17	1.20	1.45	1.60	1.80	2.00
$x - x_o$		1.1015	1.1115	1.1415	1.3915	1.5415	1.7415	1.9415
$(x - x_o)^2$		1.2133	1.2354	1.3030	1.9363	2.3762	3.0328	3.7694
y'		1.0	1.0	1.0	1.0	1.0	1.0	1.0
By'		129806						
$By' - (x - x_o)^2$		11.7673	11.7452	11.686	11.053	10.605	9.9482	9.2116
$\frac{x - x_o}{By' - (x - x_o)^2}$		.....	.....	.0977	.1260	.1454	.1751	.2103
$\log \frac{u + l_o}{l_o}$		.....	.23321	.23840	.30528	.35422	.43210	.52613
$\frac{u + l_o}{l_o}$		.....	1.7108	1.733	2.02	2.26	2.71	3.36
$u + l_o$		1.1914	1.1976	1.210	1.41	1.58	1.90	2.35
u		.491	.498	.51	.71	0.88	1.20	1.65
V		.....	.....	748	912	1011	1142	1272
P		70450	69960	68500	55440	47640	37170	27830
x	2.20	2.40	2.50	2.58	2.60	2.62	2.64	2.66
$x - x_o$	2.1415	2.3415	2.4415	.....	.....	.....	.....	2.6015
$(x - x_o)^2$	4.5860	5.4826	5.9609	.....	.....	.....	.....	6.7678
y'	1.0	1.0	1.0	.....	.....	.....	.....	1.0
By'	12.9806	12.981	12.981	.....	.....	.....	.....	12.981
$By' - (x - x_o)^2$	8.3950	7.4984	7.0201	.....	.....	.....	.....	6.2128
$\frac{x - x_o}{By' - (x - x_o)^2}$	.2551	.3123	.3478	.....	.....	.....	.....	.4187
$\log \frac{u + l_o}{l_o}$	.63920	.77550	.85509	.92550	.94938	.96392	.98267	1.00163
$\frac{u + l_o}{l_o}$	4.36	5.97	7.16	8.42	8.79	9.20	9.61	10.04
$u + l_o$	3.05	4.18	5.01	5.90	6.15	6.44	6.73	7.03
u	2.35	3.48	4.31	5.20	5.45	5.74	6.03	6.33
V	1403	1534	1599	1651.8	1664.9	1678.0	1691.1	1704.2
P	19540	12740	9950	.....	.....	.....	.....	6307

From these data the curves of velocity and pressure as functions of projectile travel may be plotted. In addition to the regular small-scale curves which show the general form of the function, it is necessary to draw also a large-scale plot for the critical points in order to allow a fair comparison between the four powders.

We will now summarize the results for Lot 1416:

Muzzle Velocity (calc.).....1689.5 ft./sec.
Muzzle Velocity (from firings).....1711.0 ft./sec.
Discrepancy 1.3%
Maximum Pressure (calc.).....70750 lbs./sq. inch
Gauge maximum pressure (calc.).....35700 lbs./sq. inch
Gauge maximum pressure (from firings) .....35090 lbs./sq. inch
Discrepancy 1.7%
Travel in feet at point of maximum pressure..... 0.49

The large-scale plots for comparing the three hypothetical powders among themselves and with Lot 1416 may be constructed from the following summary of these three powders at the "critical points":—

Powder No. 1

Percent Web Burned z	*Travel in Feet* u	*Velocity* V	*Maximum Pressure* P
1.13	0.438	.....	72630
1.14	.444	.....	72990
1.15	.449	.....	73330
1.16	.454	.....	73080
1.17	.460	.....	72610
2.60	4.64	1626.3	.....
2.65	5.21	1658.3	.....
2.67	5.48	1671.1	.....
2.69	5.76	1683.9	.....
2.71	6.06	1696.7	.....

Powder No. 2

1.13	.497	.....	68430
1.14	.504	.....	68670
1.15	.511	.....	68920
1.16	.518	.....	68590
1.17	.525	.....	68060
2.50	4.96	1636.8	.....
2.55	5.61	1670.3	.....
2.57	5.91	1683.7	.....
2.59	6.22	1697.1	.....
2.61	6.58	1710.5	.....

Powder No. 3

1.13	.568	.....	63960
1.14	.577	.....	64140
1.15	.585	.....	65310
1.16	.593	.....	63980
1.17	.600	.....	63470
2.40	5.17	1640.9	.....
2.44	5.74	1669.0	.....
2.46	6.04	1683.0	.....
2.48	6.36	1697.0	.....
2.50	6.72	1711.0	.....

Finally, we may summarize the four powders as follows:

Powder	No. 1	Lot 1416	No. 2	No. 3
Mean Web.....	0.0210	0.0215	0.0220	0.0230
Muzzle Velocity...	1692.4	1689.5	1687.4	1680.6
Max. Pressure.....	73330	70750	68920	65310
Gauge Pressure....	36220	35700	35270	34620
Travel at maximum pressure.....	0.449	0.485	0.511	0.585

From these figures we obtain the relation between the ballistics and the granulation which we started out to calculate:—

Difference for 0.001 inch mean web
in muzzle velocity.....5.8 ft./sec.
in maximum pressure.....4050 lbs./sq. inch
in gauge pressure..... 815 lbs./sq. inch

The writer wishes to express his acknowledgment to Mr. Fenwick Goldsworthy for the data on the actual ballistics of this gun and powder.

Magnum Rifles Also With Asiatic Expedition

ATTENTION has been called to the article which appeared under Professional Notes in the May-June issue of ARMY ORDNANCE, page 837, entitled "Winchester Model 95 with Asiatic Expedition," by Peter P. Carney. Several readers have gotten the impression after reading the above story that the Model 95 Winchester is the only rifle being used by the members of the Roosevelt party on its present Asiatic expedition. It was, of course, not the intention of the editor to give any such inference.

A statement by Capt. J. H. Portugal of the Hoffman Arms Company, 1765 East 27th St., Cleveland, contains some interesting data descriptive of two .375 Magnums manufactured by the Hoffman Arms Company which are also being used by the Roosevelt Expedition. In order that there may be no misconception of the type of weapon which is being used on this much heralded journey, we take pleasure in quoting the following from a letter from Captain Portugal, dated July 2nd:

"This article, it seems to me, gives the impression that the Roosevelt Expedition was solely equipped with the 405 Model 95 Winchester. As a matter of fact, this was the original intention but this was eventually changed because neither the Colonel nor Kermit Roosevelt could get satisfactory targets at distances over 100/150 yards with the 405, and after tests conducted at Oyster Bay, they ordered, for their personal use, two of the .375 Magnums made by the Hoffman Arms Company.

They also took with them fifteen hundred rounds of .375 Magnum ammunition and I give below ballistics of the above:

Weight Bullet Grains	*Bullet Muzzle Velocity*	*Muzzle Energy*
235	2767	3995
270	2600	4053
300	2462	4071

"These guns were made with Magnum Mauser action barrels of 3½ per cent. nickel steel with ½ rib and four leaf express sights, sighted and targeted to 100, 200, 300 and 400 yards—Special peep sight on the bridge of the action for point blank shooting at hundred yards. Because these rifles were to be used at high altitude and long range, 4-power Dialytan Hensoldt telescopes were fitted on specially built Noske mounts, and telescopes sighted to 100, 200, 300, 400 and 500 yards."

Small Arms Maintenance in Panama

By

CAPT. ROY L. BOWLIN, ORD. DEPT., U. S. A.

IN THE past small arms maintenance in the Panama Canal Department has been more difficult than in the States, due partly to the overuse of the old alibis "We are in the tropics" (excuse for neglect or giving the small arms improper attention at that *later* time), or "We have missed too many boats" (excuse for growing tired or forgetting).

Small arms require the proper treatment at the proper time even more than young babes. The latter can cry and make their wants known, while small arms can only show their neglect by rusting in silence and proving unserviceable when required.

Interior of Small Arms Repair Shop, Panama Ordnance Depot, Corozal, Panama

The proper care of small arms requires a long period of patient instruction of the line organizations, combined with continual follow-up work and formal inspection by Ordnance personnel.

Small arms maintenance in Panama is made more difficult during eight of the twelve months of the year due to the high humidity of the rainy season. Any steel surface exposed to the air without a protective covering of grease will rust rapidly in this climate. Add to this condition the moisture-grabbing ability of primer or powder fouling, as well as this fouling covered by metal patching, and the result on a gun barrel is almost instant ruination. It is therefore necessary to remove all primer and powder fouling as soon as shooting is finished, or in any event, not later than the evening of the firing day. In addition it is absolutely necessary to remove all metal fouling at once. If this is neglected even for a short time the rust pit beneath the fouling after removal is so deep that gas will escape past the bullet when the gun is fired again and the barrel is ruined. So the problem *is* more difficult in Panama, but the answer lies in greater care to see that small arms receive proper attention at the proper time. Proper attention is the same everywhere: remove metal fouling at once, dissolve primer and powder fouling with water (preferably hot) or some other solvent if water be not available. Then dry the barrel thoroughly. Examine to see that the gun has been properly cleaned. Cover bore with a gun grease to keep air from surface of bore. In Panama, if the arm has not been placed in permanent storage properly, it should be examined every day instead of cleaning out the grease and examining for the two or three days following firing, as is the practice in the States.

Five minutes every day set aside for small arms in the hands of troops will more than overcome the difficulty due to the more moist climate. Small arms in storage should be gone over at least once a year, and twice a year if possible. It hardly seems necessary to say that the preparation for storage should be thorough. The arms must be cleaned properly and heavily greased and stored in as dry a place as possible.

To carry out the above methods in the proper manner means work and will reduce replacement, but the work desire must be present or the arm will be neglected. Men have always been on the lookout for short cuts and means of obtaining results with less expenditure of energy. This desire has found a system of prevention of after-firing corrosion in this climate which several organization commanders "swear by" as the cureall for small arms deterioration in the bores. The armorer in this department is no less enthusiastic and knows that success can be had with the method if it be applied properly. A new test of this method, which will be described below, will be made during this firing season and results will be reported to the Ordnance Office.

This method is the use of cosmic known as "Cosmic No. 80, Black," manufactured by E. F. Houghton Company, Philadelphia, Pa. It has been used to prevent after-firing corrosion in the bores of rifles, automatic rifles, machine guns and pistols by organizations in the Panama Department; and in some organizations this cosmic has been used with poor results, possibly due to the fact

that the organization did not use the method properly.

The exact and correct procedure is as follows, and it would be very interesting if the good results claimed for the method could be duplicated by independent investigators and reported. The cosmic must be placed in the bore while the bore is hot. This must be done immediately upon the completion of the last score of the day's firing. It is to be applied to the bore by means of a thong brush (never use a patch). This brush will be screwed into the cleaning rod. The brush is then submerged and thoroughly covered with the cosmic. It is then passed through the bore of the arm from the breech to the muzzle. In passing the brush through, care must be taken to see that the rod turns with the lands and grooves through the entire length of the barrel. This is to avoid the building up of a wall of corrosion at the intersection of land and groove. This operation should be carried out with the gun in a horizontal position and the gun should be allowed to cool in a horizontal position. The point is that cosmic placed in a hot bore will melt and run and may leave exposed places. The rod is pulled through two or three times. The entire surface must be coated with the cosmic.

The arm should remain in this condition for a period of not less than eight or ten hours nor more than twenty-four hours when this cosmic should be removed, bore dried, examined, re-coated and stored. It is claimed that with this treatment the arm will keep indefinitely. The theory under which the cosmic is supposed to function is this: the hot bore has expanded and opened its pores. If allowed to cool it absorbs the primer and powder fouling and on cooling, the pores close up and it is impossible to get at the pent-up fouling which later comes out and obtains moisture after the arm has been cleaned, examined and put away in perfect condition. Now if the cosmic be placed in the bore while the pores are open, it also gains entrance and neutralizes the fouling and prevents it from later seeking moisture to cause rust. It dissolves and holds the fouling which, together with the cosmic is removed 24 hours later. It is presumed that the pores cannot absorb or include a lubricated fouling or that it comes out sooner. In any event, the system is said to be successful if properly applied.

There are 9,000 troops to serve in the Panama Department; consisting of three Infantry regiments, two coast defenses, one regiment of Engineers, one batallion of Field Artillery and the necessary supply and staff troops.

The facilities on the Atlantic side are a small arms truck and a Dodge light repair truck; on the Pacific side a small arms truck and a Dodge light repair truck and the small arms shop at the Ordnance Depot at Corozal and a small shop in the Coast Defenses of Balboa located at Fort Grant.

There is only one civilian in the department and he is a very efficient man. He has charge of the shop at the Ordnance Depot. He has enlisted men of the Ordnance Department to assist him and devotes much of his time to instruction of these men as well as inspecting and instructing the line organizations in the proper inspection, repair and maintenance of small arms.

Over a year ago all organizations were properly inspected, arms gaged and gone over completely. A record was made of rifle and repairs needed, date of repair and all such data. The following is a typical instance of the data recorded:

Type	Gage	Remarks	New Barrel	Inspected	Initial
Rifle	.301	Slightly pitted	No	3/6/22	W. C. O.
Rifle	.303	Metal fouling	No	2/9/23	W. C. O.
Rifle	.304	Deep pits	Yes	4/8/24	R. L. B.
Rifle	——	N. B. attached	R. L. B.	5/9/24	H. M.
Rifle	.301	Excellent	No	2/9/25	W. C. O.

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These cards are now on file in the Small Arms Shop at the Depot. Organization commanders were shown that their arms were in good condition and were told how they could keep them from going to ruin. A system of strict responsibility was established and the result during the past year has reduced barrel replacements by half.

The gun stocks have been boiled in sal soda solution, dried and bleached in the sun and treated with linseed oil. This improvement showed up wonderfully during the Department Commander's inspection. Dirty, dried-out stocks will quickly split and crack under the hard test of combat problems and teaching men to fall quickly aided by the rifle.

The supply of small parts to line organizations is now made by repairing the arm in one of the present facilities and expending the part. This system has reduced the heavy drain on stocks of small parts.

In order that the line organizations might have men qualified to make minor repairs on small arms, the shop at the Depot has been used as a school of instruction for selected men from the organizations. These men have shown interest, and it is believed that they will spread the knowledge they have gained of small arms and will also appreciate the work of the Small Arms Department much more than in the past.

We have been able to build up and equip a modern small arms repair shop at the Panama Ordnance Depot. Here we are able to make repairs of a major character on all small arms, that is, changing barrels, headspacing, replacing broken side plates on machine guns, soldering leaky water jackets, etc. We are also able to polish the component parts of small arms preparatory to bluing and browning.

The changing of barrels on rifles was our biggest problem, because we had to procure satisfactory special tools for this work. These consisted of heavy vises with suitable jaws attached and the proper headspacing tools, consisting of finishing reamers, master bolt and the minimum and maximum gages. Barrels stripped as issued us by manufacturing arsenals are only reamed to approximate minimum measurements so that after a barrel is fitted to a receiver it can then be reamed to fit the receiver on which it is to be equipped. This is a very careful operation, because if it is reamed too much excessive headspace will result, which generally terminates in ruptured cartridges and hard bolt manipulation when using the rifle for rapid fire.

Small arms maintenance in the Panama Canal Department is more difficult than in the United States, but it is not an excessive burden if proper instruction in the care of arms is given, if inspections are conducted to see that instructions are carried out, and if the pride in beautiful arms that a soldier should have is instilled in the soldier and his company commander.

Military and Commercial Powder and Explosives

By

COL. W. C. SPRUANCE, ORD. RES.

THERE is a misunderstanding in the minds of many as regards powder and high explosives of various kinds in relation to industrial preparedness and national defense. Many persons think that all explosives can be used effectively as ordnance matériel or that most of the products of commercial powder and explosives plants can be employed by the Army and Navy and that the country could depend, in case of necessity, on the output of the various peace-time explosives establishments to supply our troops.

Col. William C. Spruance

Such a condition is far from being the case. During the past twenty-five years the developments in military propellents and explosives for bursting charges have been along lines materially different from those along which peace-time products have been developed. Generally speaking, commercial dynamite and black blasting powder cannot be utilized as war munitions for troops. Some forms of dynamite were used during the World War for certain demolition work by the Army engineers and black powder of suitable type was employed for shrapnel projectiles and time fuzes, etc. Peace-time production of TNT and nitrate of ammonia (amatol being a mixture of these) represents only a small fraction of the amounts which were required to meet the schedules in effect prior to the signing of the Armistice. Commercial peace-time activities in the production of smokeless powder (the World War propellent which was produced at the rate of several hundreds of millions of pounds per annum) are limited to relatively insignificant quantities to meet Government orders and sporting powder for rifles and shot guns.

It is important from an ordnance point of view to keep these facts in mind, for in case of another national emergency, propellents, shell-bursting powders and high explosives supplies could not be procured in significant quantities from commercial factories without extensive changes and additions to existing processes and equipment, and there should be a reserve of such material on hand and available until plants could be built with productive capacity sufficient to keep the Army supplied.

Thus the production of powder and explosives for Army and Navy ordnance offers a special problem, for, whereas clothing factories could immediately begin to make uniforms for the troops; automobile factories could turn out trucks for war use; existing rifle factories could make small arms for field service, and many other war supplies could be immediately obtained in significant quantities by mobilizing industry, the existing commercial explosives plants could not be employed to any important extent to furnish propellents and bursting charges.

A few generations ago this was not the case. From the time of the battle of Crecy in 1346, when a western nation first used gun powder in war, until long after our Civil War, a period of over five hundred years, black powder was the only explosive manufactured. It was used for blasting purposes, for sporting arms, and for all kinds of guns in war. It was a mechanical compound of saltpetre, charcoal and sulphur and an article of commerce produced for ordinary commercial needs by plants regularly established and maintained in times of peace. Powder factories of that day, like the clothing factories of our time, could be converted and utilized in the making of supplies for the Army with little difficulty.

A few years before the Spanish-American war military propellents of the smokeless powder type were developed, and these have taken the place of old-fashioned black powder. They are entirely different products and their manufacture involves complex operations. Instead of being a mechanical mixture as is black powder, they are chemical compounds; to-wit, nitro-cellulose colloids. Moreover, they cannot be successfully used in the ordinary peace-time operations of mining, quarrying and other blasting activities, and therefore there is no wide commercial

demand for them; hence no factories exist which make them on a large scale for industrial purposes. The same situation applies in large measure to the bursting charges, which, during the World War, consisted principally of picric acid, TNT and nitrate of ammonia, the latter being the only one which is commercially produced in peace time at any appreciable fraction of the war-time rates of production.

We have, therefore, reached a point where military propellents and bursting charges are to all intents and purposes largely separate and distinct from commercial powder and explosives, with such minor exceptions as black powder made on special formulae for priming smokeless powder charges, and for time fuze for shrapnel and high explosive shell or slow fuze for hand and rifle granades, etc. Black powder is also used as a bursting charge for shrapnel and for impulse charges of torpedoes and the ignition of depth bombs.

It must not be thought, however, that commercial explosives, such as black blasting powder and dynamite, do not play an important part in time of war. They serve a vital purpose. The mobilization of industry is recognized to be quite as important in the conduct of modern warfare as the mobilization of men, and the basic industries of mining, manufacturing and transportation, are in large measure dependent upon explosives. Metals for guns, ships, aeroplanes, trucks and tractors; for locomotives, rails, factory machinery and farm implements are mined with explosives. Stone for flux in the ore furnaces, for concrete and other forms of construction is quarried with explosives, and coals for the power requirements of manufacture and transportation are dependent upon commercial powder and explosives.

The importance of the explosives industry in the problem of speeding up and maintaining war-time production is realized when one remembers that during the year 1917 the peak of production and use of black powder in the United States was reached, amounting to over 11,000,000 kegs, while the corresponding figure for the year 1924 was a little less than 7,000,000 kegs. The production of dynamite in 1917 was about 330,000,000 lbs., which was a maximum to that date, the figures for subsequent years first showing a falling off and then an increase, until in the years 1923 and 1924, respectively, the total production was between 340,000,000 and 350,000,000 lbs.

Even more significant is the fact that when the Armistice was signed, the actual producing capacity in the United States for smokeless powder exceeded 700,000,000 lbs. per annum (and if plants then under construction had been completed this figure would approximate one billion pounds), whereas in 1924 the corresponding figure would hardly exceed 20,000,000 lbs. Similarly the per annum capacity of plants actually producing TNT at the time of the Armistice totaled over 150,000,000 lbs., with perhaps 18,000,000 lbs. as the 1924 figure.

The accompanying illustrations may serve to emphasize an important distinction between military and commercial high explosives as applied to peace and war-time requirements respectively.

Since 1918 a number of improvements have been made in commercial explosives, which have considerably increased the speed and efficiency of blasting and mining operations. Practically all types of dynamite are now made on low freezing formulae, which means that they may be used during the coldest weather conditions and without the hazards formerly involved in thawing frozen explosives. Explosives of the so-called "permissible" type for use in gaseous and dusty coal mines have been improved as regards density and velocity of detonation, which has resulted in increasing the percentage of lump coal and decreasing the amount of slack incident to their use. Probably the greatest improvement realized is the development of the modern gelatin dynamite, the explosive extensively used in underground ore mining and tunnel driving in solid rock. This is now made with so much less objectionable fumes than formerly that mining operations can be resumed within one-half hour after the charge is detonated, thereby appreciably speeding up the operations in which it is used underground. Insofar as such improvements in commercial explosives increase the productivity of the industries which supply war materials, they are significant from the military point of view.

It may be of interest to refer very briefly to a few instances in which modern explosives have played an important part in major construction projects in recent years. The Shandaken tunnel involved in the development of New York City's water supply, which has a length of 18.2 miles, is the longest tunnel ever driven, and nine miles of it were blasted through solid rock in a single year, the average "pull" per shot in 1922 being 9.2 lineal feet.

In the hydro-electric development, involving the damming of the Dix River at Burgin, Ky., which at this point flows between limestone cliffs 300 ft. high, 25,000 cu. yds. of rock were thrown in a single blast from the cliff face to the bed of the river when starting the rock fill for the dam, the complete project involving the use of approximately 500,000 pounds of dynamite.

A good example of underwater blasting with gelatin dynamite is the deepening of the channel through Hell Gate in the East River, N. Y., involving the removal of bed rock from the bottom of the river to deepen the channel to 35 ft. and permit merchant vessels and battleships drawing more than 30 ft. to pass between New York Harbor and Long Island Sound.

The use of commercial explosives for peace-time purposes is increasing in connection with ditching for drainage projects, and demolishing old buildings, stacks, ice jams, etc., and clearing snow from railroads and highways in mountainous districts.

Time and technical development of both commercial and military powders and explosives move apace. Picric acid is not likely to be an important item in the list of bursting charge explosives in any future war. Trinitrotoluol will perhaps be supplemented by quantity production and use of trinitroxylol and other nitro compounds. Amatol established for itself in the World War an important and perhaps lasting place in the list of ordnance matériel, but further improvements and radical modifications of process and product are probable as time goes on. Single and double base smokeless powders are undergoing material improvement, and the next war may see the vast production and use of nitrocellulose propellents, causing little, if any, muzzle flash, minimum erosive effect on the gun barrel, possessing almost indefinite stability and withal practically non-hygroscopic, thus with-

standing successfully the wide variation in limits of temperature and humidity unavoidably incident to the war-time storage, handling and use of military propellents. Not only have there been, in the last six years, radical improvement in propellents for coast defense, field and antiaircraft guns and small arms, but also tracer and incendiary rifle ammunition have benefited greatly as a result of further research and experimentation leading to more uniform functioning, greater accuracy, and longer duration of the charge. Tracer ammunition for antiaircraft guns has also reached a high state of efficiency. As regards the high explosives bursting charge of drop bombs detonated by both instantaneous and delay fuzes, post-war developments have been especially significant. U. S. Ordnance is in the forefront of progress in this category involving the successful design and production of the world's largest bomb, weighing 4,000 lbs. and containing a demolition charge of nearly a ton of high explosive.

Generally speaking, it may be said with assurance that the development in military powders and explosives has been greater since the signing of the Armistice than in the previous twenty years.

We should also remember that the primary and major basic element essential for the production of both commercial and military smokeless powder and high explosives is nitrogen, and that whereas during the World War our main supply was derived from Chilean nitrate of soda, we may, before the next war, be drawing on the nitrogen of the air, and in this respect be independent of imports and, through synthetic processes, have available in this country quantity production of ammonia and nitric acid from plants susceptible of unlimited expansion and supply of basic raw materials to provide the vast quantities of military propellents and explosives which the requirement schedules of the next war may comprise.

The significance of such probable developments is also obvious in connection with supplying chemical warfare items of matériel in addition to any ordnance program. The firm establishment of the dyestuffs industry in this country and the close relation of some of its products to explosives, and many of the major compounds applicable to chemical warfare, are outstanding features of our country's progress in recent years.

Incidentally, it is interesting to note the success attendant upon the efforts of industry to utilize surplus supplies of powder and explosives released by the Government since the World War. As a minor item, picric acid is being used in the dyestuffs industry and in a major category, large quantities of smokeless powder and nitrate of soda have, with the aid of industrial corporations, been made available, through the development of new formulae and processes, for use as explosives in connection with clearing of land and building of roads, etc., in addition to use in the manufacture of pyroxylin plasties, films and surface finishes for commercial use.

Another evidence of the coöperative spirit existing between the representatives of the Government and the industries is the recent movement toward the compilation of certain technical and process histories which further emphasize the radical differences between commercial products and munitions. For example, production of certain explosive compounds in this country entirely ceased with the signing of the Armistice, with no likelihood of their manufacture being resumed under peace-time conditions, with the natural result that by the time another national emergency arises, such processes are likely to become

Fig. 1

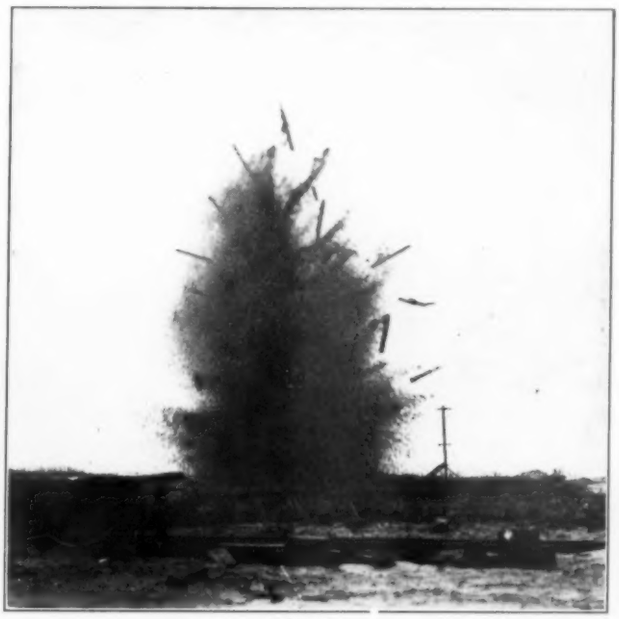


Fig. 2

HIGH EXPLOSIVES BLASTS IN PEACE AND WAR

Fig. 1—A section of a large drainage ditch forming a part of a waste land reclamation project, with the excavation resulting from the use of commercial dynamite and the blasting of the next section. **Fig. 2**—A demolition burst of a large bomb loaded with TNT. These illustrate peace-time constructive and war-time destructive uses of high explosives. The reader is reminded that the limiting conditions of storage, handling, application and manufacturing cost of TNT and dynamite respectively, render the latter suitable for numerous peace-time purposes, but unsuitable for use as a bursting charge of either gun projectiles or bombs.

lost arts, this condition indicating the necessity of carefully compiling and recording comprehensive process and equipment data relating thereto. Analagous conditions apply to other industries to a greater or less extent.

While it is the duty of the World War generation of officers and civilians to preserve for posterity such data and experience, it is encumbent upon the rising generation to exercise an active and personal interest in the prospective problems of the next war, particularly as the responsibility for its munitions production program may fall upon their shoulders.

The members of the A. O. A. will find many interesting comparisons and distinctions in their own lines of industrial activity when viewed from both the war and peacetime standpoints. There is an important duty devolving on our younger members, both present and prospective, in relation to this problem which is a major objective of our organization in its efforts to avoid war and contribute to the cause of national defense by being potentially prepared—both technically and productively—for real and complete industrial mobilization in the event of another actual or even threatened national emergency.

District of Columbia Ordnance Reserve Officers Close Active Season

THE activities of the Ordnance Reserve Officers of the District of Columbia were brought to a fitting close after a Winter and Spring season of training classes with a smoker at the Sterling Hotel, Washington, D. C., June 4, 1925, at 8 P. M. Maj. Gen. C. C. Williams, Chief of Ordnance, presided and addressed the officers complimenting them upon the active co-operation they had given during the year and urging them to continue the good work.

During the past year the Ordnance Reserve Officers in Washington have been attending bimonthly classes of instruction at the headquarters of the Organized Reserves in that city, at each of which lectures were given by a member of the staff of the Office of the Chief of Ordnance supplemented by talks on military courtesy and discipline by Maj. R. P. Harbold, Office of the Quartermaster General.

The course was under the general supervision of Lt. Col. John Scott, in charge of Organized Reserve activities in the District of Columbia, whose enthusiasm and tireless efforts in the interests of the Reserve is one of the outstanding features of that branch of the service in the National Capital. Colonel Scott also addressed the meeting and congratulated the Ordnance Reserve as having one of the best attended units during the year.

Maj. C. G. Mettler, Assistant to the Chief of the Technical Staff, Office of the Chief of Ordnance, addressed the members and explained the various activities of that important branch of the Ordnance organization.

Maj. John A. Brooks, Jr., in charge of reserve activities in the Office of the Chief of Ordnance, told of the plan for summer training camps at Aberdeen Proving Ground and Rock Island Arsenal.

Those present at the final meeting included, in addition to General Williams, Brig. Gen. John W. Joyes, Assistant to the Chief of Ordnance, Major Mettler, Major Brooks, and Major Harbold, the following invited guests:

Maj. R. R. Nix, Office of the Assistant Secretary of War;
Maj. R. L. Maxwell, Secretary of the Army Ordnance Association;
Col. Frederick H. Wagner, Ord. Res., of Baltimore;
Capt. H. S. Wilkins, Executive Assistant, Baltimore District Ordnance Office;
Maj. Harry Kutz, Ordnance Officer, 3rd Corps Area; and
Maj. W. C. Young, Fort Bragg.

The following Reserve Officers were present:

Lt. Col. I. Weil,
Lt. Col. F. E. Wright,
Maj. D. St. P. Gaillard,
Maj. J. C. Gray,
Maj. Sharpe Ireland,
Maj. C. E. McRae,
Maj. L. W. Searles,
Capt. E. J. Almquist,
Capt. M. F. Barnes,
Capt. Humphrey Becket,
Capt. P. B. Campbell,
Capt. L. A. Codd,
Capt. J. L. Delany,
Capt. Chas. Demonet,
Capt. W. M. Jefferys,
Capt. J. C. Karnes,
Capt. Wm. F. Mahony,
Capt. H. D. McCook,
Capt. J. H. Nichols,
Capt. A. T. Pagter,
Capt. M. H. Resni Coff,
Capt. L. G. Schmidt,
Capt. F. S. Steward,
Capt. C. G. Toepper,
Capt. E. S. Van Brunt,
Capt. Wm. F. Whittington,
1st Lieut. Wm. L. Allison,
1st Lieut. E. L. Davis,
1st Lieut. L. W. Holland,
1st Lieut. H. H. Mitchell,
1st Lieut. A. C. Oliphant,
1st Lieut. C. H. Strand,
2nd Lieut. J. A. Dore,
2nd Lieut. M. P. Guida,
2nd Lieut. A. B. Hansen,
2nd Lieut. J. A. Hickey.

The New Packard Tank Engine

By

H. F. OLMSTED

AS A RESULT of co-operation between the Ordnance Department and the Packard Motor Car Company this Company has recently perfected an engine to meet the unusual and severe conditions of tank operation. In the development of this engine, the effort was made to use many parts in production, and yet have the completed engine so designed as to meet all the special conditions of operation to which it would be subjected when operating in a tank.

It was possible for the Ordnance Department to specify the expected performance of the engine for this tank, because of the intensive test programs which have been carried on with tanks built during and since the World War. The general requirements resulting from observation and study of these tests, are compactness, accessibility, dependability and unusual cooling ability.

More study, possibly, was given to the question of cooling than to any other one feature. As a result, the motor when completed was operated in a box continuously for five hours with wide open throttle and the temperature at the water outlet exceeded the atmospheric temperature inside the box by only 20 degrees.

The dimensions of the engine compartment in the tank were fixed before the work of designing the motor was started. Consequently the motor had to be designed to fit into limited space and still give room enough to remove the heads for valve grinding and making the accessories, unusual in number and size, accessible.

Because the question of vibration was not a problem for consideration, the natural vibration of the tank itself being far greater than any which could be caused by the power plant, an eight cylinder Vee type was selected. This design made possible the compactness necessary and the inherent disadvantages of an eight cylinder Vee type engine were not given serious consideration.

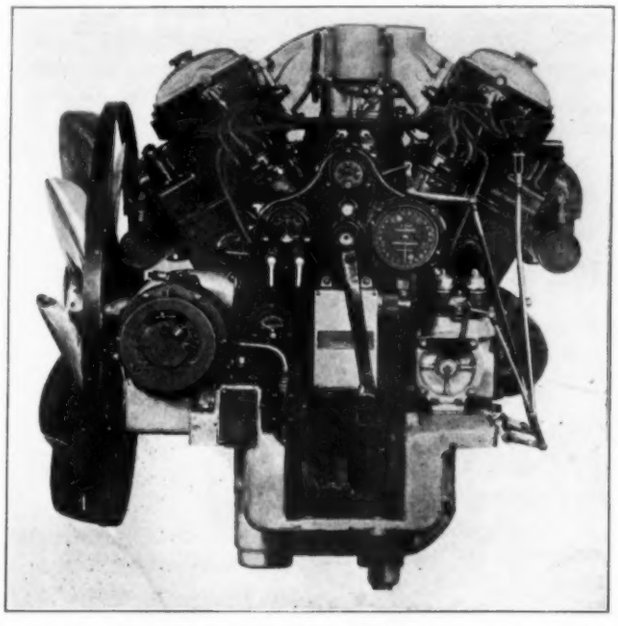
The engine has a bore of 5½ inches and a stroke of 7 inches. At 1,200 revolutions per minute it develops 200 horsepower and it can be operated up to 1,800 revolutions per minute. There are five main bearings with large flanges at the rear bearing to absorb the thrust when the engine is operating at an angle of forty-five degrees.

The cylinders are cast enbloc with an unusual design which permits their ends to come flush with the ends of the crank case to which they are bolted, a factor making for compactness. Cylinder heads are so designed that they may be easily removed from the front end for valve grinding. There are two valves for each cylinder and the exhaust valves are oil cooled, an important feature adapted from the new Packard aircraft engines. These same engines furnished another feature in the multiple type valve springs, a discovery of the Packard engineers which has been a guarantee against breakage of valve springs.

Each cylinder has two spark plugs, the outside plug on each being set in an unsual way to make it more readily accessible. The battery generator type of ignition is used.

An air compressor, gasoline pump, generator, hand starter, electric starter, governor, water pump, two ignition distributors, oil pump and tachometer all are located at the front end of the engine besides a small instrument board carrying the usual gauges, switches, etc. The air compressor is of size sufficient to furnish compressed air for the tank controls.

The cooling fan is located at one side of the motor and is 36 inches in diameter. It is driven through a friction clutch which slips under rapid acceleration of the engine. The fan travels at 12 per cent. greater speed than the motor which, because of its great diameter, gives a high peripheric speed. The fan is made of aluminum blades, each fastened to a light hoop of steel, or rim, at the outer end.



The New Packard Tank Engine Showing Instrument Board and Cranking Handle

The general specifications under which this new engine was developed follow:

General Specifications

Model—1T-1330.
Number of cylinders—Eight
Bore—5½".
Stroke—7".
Displacement—1330 cu. in.
Type—60 degree Vee, water cooled.
Rated horsepower — 200 Brake Horsepower at 1200 r. p. m.
B. M. E. P. at rated horsepower — 99 lbs. per sq. in.
Compression Ratio — 4.75 to 1.

Crankshaft—Five-bearing type with large flanges at rear bearing to absorb thrust when engine is operating at an angle of 45 degrees.

Main bearing diameter—3″.

Main bearing lengths:
Front end—2¼″.
Center—3″ Crankshaft.
Rear—3⅛″
Dimensions.
Intermediate—2″

Main bearing material — Bronze-backed babbitt.

Crank cheek maximum cross section—1″x3¾″.

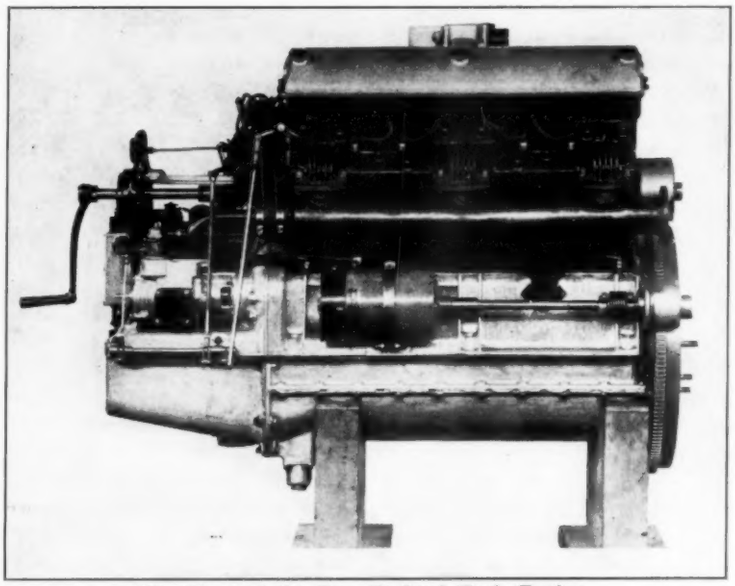
Crankpin diameter —2½″.

Crankpin length—2½″.

Camshaft — Single camshaft located in the Vee with separate cams for each valve.

Connecting Rod type —Forked.

Connecting Rod bearing material — Kelmet.



Side View of the New Packard Tank Engine

Forked rod bolts—Four 3/8-24.

Plain rod bolts—Two 7/16-20.

Connecting rod length—13″.

Piston pin diameter—1⅜″.

Pistons—Slipper type. Three ⅛″ width rings. Die cast aluminum alloy.

Crankcase—Split 3″ below the centerline of the crankshaft. Main bearings carried by independent caps. Crankcase lower half performing function of oil pan.

Cylinder centers—6½″ except between No. 2 and No. 3—7½″.

Cylinder construction—Cylinders to consist of two 4-cylinder block castings with separate cast iron detachable heads carrying the valves and rocker arms.

Valves—Two valves per cylinder, located on the fore and aft line ¾″ offset from the centerline of the cylinder. Exhaust valves to be oil cooled. Quick detachable cover to house rocker arms and valve gear.

Valve material—Silchrome.

Valve dimensions—1⅞″ in the clear.
45 degree seats.
⅜″ lift.

Valve springs—Multiple type.

Valve action—Push rods and rocker arms.

Rocker arm bearings—Bronze bushings with forced feed lubrication.

Accessory drives—For the following accessories driven at the percentages of crankshaft speed given:

Radiator fan	@	112%
Air Compressor	@	50%
Gasoline Pump	@	66%
Generator	@	155%
Hand Starter	@	100%
Electric Starter Motor	@	1500%
Governor	@	147%
Water Pump	@	100%
Ignition Distributors	@	50%
Oil Pump	@	127%
Tachometer	@	50%

Accessory and camshaft drive gears—Spur type 6-8 pitch except fan drive through bevel gears.

Lubrication — Dry sump system with triple gear oil pump operative with engine at 45 degree angle in any direction. High pressure feed to all bearings.

Cooling System — Double impeller, centrifugal type, with single water inlet to each cylinder block and single outlet from inlet cross header jacket.

Air Compressor—Brunner No. 105, two-horsepower, running at 45% of engine speed.

Gasoline Pump—Oberdorfer, type No. 1Z, running at 66% of engine speed.

Carburetor—Stromberg duplex type NA-Y5, double float type. Will operate at extreme angles. Supplied with mixture control.

Primer—Hand primer of fuel injection type supplied for starting.

Ignition—Delco twin distributor carrying two independent eight-cylinder distributor heads furnishing two sparks to each cylinder.

Governor—Centrifugal type with external adjustment permitting of varying the maximum engine speed from 1200 to 1500 r. p. m.

Fan—36″ diameter, running at 1.12 times engine speed.

Generator—Leece-Neville constant voltage type. 7″ diameter. Output 1 K. W. at 15 volts (67 amperes).

Starter Motor—Leece-Neville 6″ starting motor geared to the flywheel through heavy duty Bendix gear.

Hand Starter—Bar type with back-kick safety device.

Maximum Fuel Consumption—.55 lbs./b.hp./hr. at rated r. p. m. and horsepower without accessories or .58 lbs./b.hp./hr. with accessories in operation.

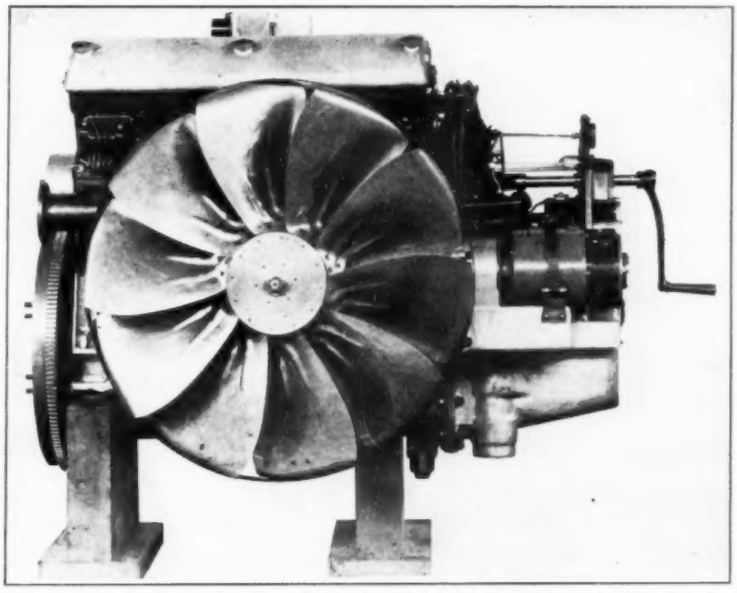
Maximum Oil Consumption—.03 lbs./b.hp./hr. at rated r. p. m. and horsepower.

Weight of engine with accessories not including radiator, fan, storage battery, or flywheel—1250 lbs.

The original layout studies for the tank suggested an eight-cylinder V-type engine, similar to aircraft engines because the engine compartment was quite restricted and one of the major problems was to design an engine with

the required output and at the same time provide accessibility to such parts of the engine as might require adjustment or inspection while in service.

The general arrangement of the tank is such that the front of the engine is alone accessible from the inside of the tank, there being two 19" doors provided between the engine compartment and the operator's compartment. It was therefore determined to group the accessories at this end of the engine thus following in a general way the design of the Packard model 1A1551 engine which had similar requirements in regard to accessibility.



Side View of the Packard Tank Engine Showing Novel Fan Arrangement

After careful consideration of the speeds at which this engine was required to run and the heavy duty load characteristics it appeared that the requirements were best met by an eight-cylinder 60 degree Vee-type engine in accordance with the original plan, but using more rugged construction than afforded by similar high power aircraft engines.

An important consideration in this connection was the necessity for securing access to the valves without removing the engine bodily from the tank. This practically dictated a detachable head design, the head carrying the valve gear. Due to the comparatively low speed at which this engine is normally operated it was decided to use push rod operation for the valves as this construction greatly simplifies the gear layout and eliminates the necessity for retiming the engine after removal of the cylinder head.

A natural sequel to the decision to use a single camshaft in the Vee for the operation of all the valve gear was the provision of spur gears for all accessory drives. In this manner it is possible to replace the sixteen bevel gears contemplated with the Liberty engine by nine spur gears. It is felt that a spur gear layout is far preferable to a bevel gear layout since the gear centers are absolutely fixed in the former case, whereas in the latter provision has to be made for absorbing the thrust of the gears as well as for shimming to insure correct meshing, all of which requires greater care and skill on the part of the mechanics engaged in handling the engine.

Cylinder Construction

The cylinder construction received careful consideration. The twelve-cylinder Liberty engine had been adapted for wartime models of the heavy tanks but cast iron cylinders were substituted for the standard built-up steel cylinders. Experience has shown that the conventional type of built-up steel cylinders is not satisfactory for tank work since the engine mounting is necessarily far more rigid than in an airplane, the load conditions are far more severe and the general vibration is of far greater intensity, all of which tend to cause cylinder jacket leaks in service.

An alternative construction would consist of an aluminum cylinder block with steel liners but it is believed that a cast iron cylinder block is preferable in spite of the somewhat greater weight. One of the chief advantages of a cast iron block lies in its simplicity and ease of manufacture with practically positive assurance that it will not develop water leaks in service. It is estimated that the cast iron cylinder block will weigh approximately 200 lbs. more than an aluminum block but it is believed that the simplicity and additional reliability warrant the former construction.

Cylinder Head

The cylinder head construction follows conventional practice, special attention being given to securing a large number of equally spaced hold-down studs to eliminate any possibility of trouble with cylinder head gasket.

Valve Gear

The valve gear also follows conventional design except in respect to valve springs and exhaust valve cooling. The valve springs are of the multiple type successfully employed on Packard aviation and marine engines and consisting of seven piano wire springs of small diameter which, due to their far greater natural period of vibration as compared with the conventional large diameter coil springs, give infinitely better service. The exhaust valves are cooled by a forced circulation of oil through their hollow stems and hollow heads and this construction is also being followed in Packard aircraft engines.

Accessory Drives

The first layout submitted by the Ordnance Department showed the accessories grouped in a satisfactory manner, but were mostly driven by bevel gears. The final arrangement of these parts was left to the engine designer in order to work them out to the best advantage. The decision to use spur gears in the place of bevel gears had considerable influence on this redesign and in general an effort was made to secure the greatest possible accessibility at the front end of the engine. The various drives are considered in detail below.

Water Pump

The water pump is driven direct from the crankshaft, the pump shaft being provided with a splined end to

engage the crankshaft. With this construction a single bearing only is required and the rear stuffing box is of the automatic spring compressed gland type. The water pump shaft, which is 1¼″ in diameter, is brought through the front end of the pump and is utilized for engagement of the cranking bar. This location of the water pump is naturally accessible, gives a suitable drive ratio for the pump and symmetrical piping to the two-cylinder blocks.

Oil Pump

The oil pump is located below the water pump and is driven from the crankshaft gear through an idler. The pump in general design and location is similar to the unit used in the model 1551 engines and is of three stage construction. Two of the gear pumps are suction pumps and draw the oil from the rear and front end of the crankcase sump respectively discharging the oil to the external oil tank. With this construction the sump will be maintained dry regardless of the inclination of the engine. The third pump is a pressure pump drawing oil from the oil tank and delivering oil through a combined relief valve and strainer assembly, located on the top of the timing gear case, to the bearings throughout the engine.

Camshaft

As a single camshaft operates all the valves the drive is greatly simplified and the camshaft is driven from the crankshaft through a single idler which also drives the air compressor. The gears are heat treated alloy steel of 6-8 pitch and 1¼″ face of similar construction to that employed in the model 1551 engines.

Ignition Distributors

The twin ignition distributors are mounted in a standard Delco housing and driven from the front end of the camshaft through a flexible coupling of the molded rubber type. The same construction has been successfully used in the Packard model 1551 engines. The distributor is of strictly standard construction and is provided with a manual advance lever.

Tachometer

A standard aircraft engine type of tachometer drive is provided on the front end of the distributor, this shaft running at ½ engine speed as is standard practice.

Governor

A centrifugal governor of similar construction to that used on the model 1551 engines is driven off the camshaft gear and is located in the Vee. This location renders the hookup to the carburetor simple and direct. The governor spring tension can be adjusted from the switchboard, as required in the specifications, by means of an external lever and connecting rod.

Air Compressor

A drive is provided for a model 105 Brunner, two-horsepower, air compressor mounted on a shelf bracket integral with the timing gear cover on the right hand side of the engine. This drive is furnished by means of a spur gear mounted on the stub shaft and provided with internal teeth. It is intended that the air compressor should be furnished with a flywheel fitted with external teeth to mesh with the internal teeth of the spur gear. This construction provides for a certain amount of misalignment. In this connection it is deemed essential that the air compressor be supplied with a flywheel in order to minimize the variations in torque.

Generator

A large capacity generator is mounted on the left hand side of the cover by means of a flange mount designated by the Arsenal. This generator runs at 1½ engine speed. The generator driving gear shaft is carried to the rear to furnish a drive for the fan.

Radiator Fan

In the original layout an open chain drive was shown to operate the 36-inch fan. It is felt that a more satisfactory drive could be furnished by the shaft drive, but it is considered essential that the fan be mounted on its shaft by means of a friction clutch which should be set to such a value as to slip under rapid acceleration of the engine. Similar construction has been used successfully in positively driven automobile fans.

Electric Starter Motor

In line with the decision to specify only such equipment as has been definitely proven satisfactory, a starter construction similar to that employed on Packard marine engines has been specified. This comprises a 6-inch starting motor operating on twelve volts and geared to the flywheel with a 15 to 1 ratio operating through an idler gear and a specially developed heavy duty Bendix engagement.

Hand Starter

After careful consideration it was decided to specify a hand bar starter which has been successfully used on the model 1551 engines. It is believed that this construction is far more satisfactory than any gear reduction type. Safety to the operator is assured by means of a back-kick release.

Crankshaft Thrust Bearing

Experience has shown that with an engine of the size contemplated a flywheel must be fastened to the crankshaft either by a flanged connection or on a comparatively slow taper. The practically instantaneous reversals of torque are such as to tend to loosen the flywheel from the shaft. It was therefore decided to adopt a flanged attachment as is conventional practice and the thrust is taken care of by large diameter thrust flanges formed on the rear bearing, which is of babbit material. With the proportions used the unit pressure does not exceed 50 lbs. per sq. in. even were the engine run with its crankshaft vertical. Similar thrust bearing construction has been used successfully on both the model 1551 engine and on Packard marine engines where similar thrusts are encountered.

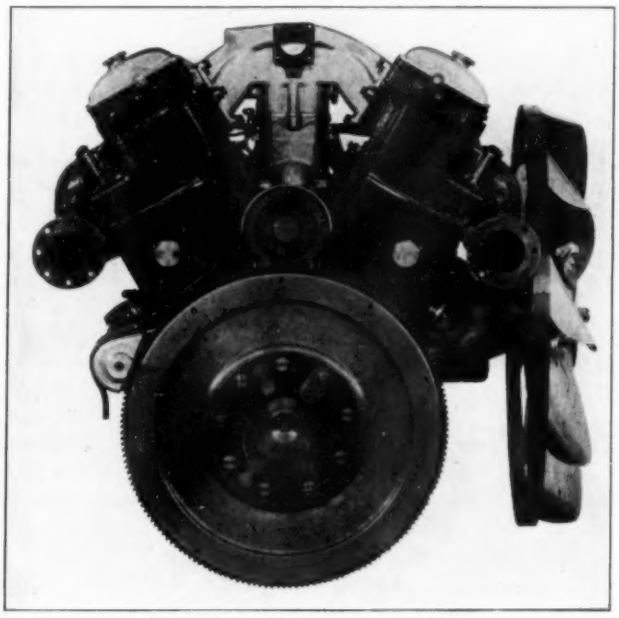
Gasoline Feed

A No. 1Z Oberdorfer gear pump is driven off the air compressor drive idler. This gear pump has a self-contained spring loaded by-pass valve which permits of maintaining constant pressure on the fuel line leading to the carburetor.

Weight of Engine

In this respect the engine under discussion does not strictly comply with the specifications which call for a maximum weight of 1000 lbs. exclusive of the radiator, fan, storage battery, flywheel and clutch. A preliminary estimate of the engine as designed would indicate that it would weigh approximately 1250 lbs. This, however, includes both the drive and mounting for the fan and air compressor.

As stated previously it is recognized that this excess weight could be eliminated by using a lighter type of cylinder construction, employing an aluminum block in place of the cast iron construction shown, but the heavier construction was adopted in the interest of reliability.



End View of the New Engine

Summary

It is believed that the engine described is of rugged design and particularly well adapted to tank work, although it would also be applicable to heavy tractor or railcar duty.

The engine has been primarily designed to develop its output without resorting to extremely high compression values and the bearing surfaces throughout and method of lubrication are such as to insure extremely long life. The provision for oil cooled exhaust valves and Kelmet bearings will greatly prolong the time between overhauls and the various units have been so located that it is believed their individual replacement can be carried out in service in minimum time.

The Aldershot Command Searchlight Tattoo

THE Aldershot Command Searchlight Tattoo, a great military spectacle presented annually by the troops of the Aldershot Command, England, in aid of "The Aldershot Command Military Charities," was held June 16 to June 20, 1925. The Tattoo is a spectacular demonstration organized to interest the public, the proceeds being devoted to various military charities. It is held on four successive evenings in the Rushmoor Arena, Aldershot. Stands accommodating some 30,000 people make the setting particularly attractive and enable the military authorities to carry out the display to maximum advantage. The estimated attendance this year for the four performances was placed at 150,000. Some 3,000 troops took part and another 1400 men in the different musical organizations participated.

The greater part of the program was given over to music. The special features of this had to do with the great massed bands which manoeuvered in impressive style while playing appropriate and inspiring numbers. With numerous searchlights serving as flood and spot lights, full theatrical effect was produced. The interesting feature of the "Illuminated Musical Drill" by the Royal Horse Artillery, was the outlining of carriages, guns and harness with incandescent lights carried by storage batteries in the caissons.

The main feature on the program was "A Combined Display" consisting of two parts. The first visualized war as of 1815, and pictured an incident of the battle of Waterloo. The second part depicted war as waged in the twentieth century. In the former, French and British troops were dressed exactly as they were in the battle of Waterloo; in the second part all modern weapons and services were brought into play, including aircraft, tanks, tractor-drawn artillery, gas, smoke, antiaircraft artillery, radio, camouflage, and motor ambulances.

The great success of the demonstration well repaid those in charge for the great amount of time and effort spent in making the affair a success. Drill formations were executed in good order and showed that much careful attention had been given them. The grand scale on which the entire demonstration was carried out undoubtedly appealed to the men who took part in it and who succeeded in producing a most favorable impression on the many thousands present.

The schedule of events was as follows:

9:30 p.m.	Sounding of the "First Post";
9:36	Selections by Massed Bands;
10:14	Fan of Searchlights;
10:15	Entry of Massed Drum and Fife Bands;
10:23	Illuminated Musical Drill;
10:36	Massed Trumpeters;
10:38	Waterloo, 1815;
10:56	An Interlude "Vulcan";
10:58	Zephon;
11:06	Entry of Massed Pipe Bands;
11:15	Fireworks Display;
11:23	Entry of Massed Bands and Torchbearers;
	Finale by Massed Bands;
	Sounding of the "Last Post."

All arrangements connected with the demonstration were carried out perfectly with the possible exception of traffic control. As the great majority of the spectators had to travel from a distance, the motor traffic was particularly heavy and resulted in considerable congestion. This may be explained somewhat by the unexpectedly large attendance, nearly 70,000 more than the preceding year.

Financially the Tattoo of 1925 was a great success. It is understood that the receipts were nearly $100,000 which will be devoted to the various charities comprising the Aldershot Command.

Hawaiian Joint Maneuvers, 1925

THE following extracts from a statement by Maj. Gen. John L. Hines, Chief of Staff, U. S. A., on the recent Hawaiian Grand Joint Maneuvers, should be of interest to readers of ARMY ORDNANCE. General Hines was one of the chief umpires of the exercises.

"The Grand Joint Exercise in Hawaii was the biggest and most interesting one ever held by our Army and Navy. It had two principal objects: 1. To test the project and plans for the defense of Oahu; and, 2. To train Army and Navy in joint operations.

"The problem for the exercise was drawn up by the Joint Board and was extremely simple in form, although its solution was difficult for both sides. The following facts were assumed: 1. That a state of war existed between Blue (the United States), and Black; 2. That the Hawaiian Islands were a Black possession and were defended by the existing armament, the present naval district forces and a garrison of approximately 14,000 men; and, 3. That Blue was desirous of capturing Oahu with the object of making use of it as a naval base.

"The Blue Fleet, accompanied by an expeditionary force of two divisions of troops, was concentrated in San Francisco and put to sea April 15. Under the terms of the problem, the transports accompanying the Fleet were not to be farther than 1,700 miles from San Francisco at 5:00 A. M., April 25, 1925, the hour and date when the problem actually opened. The Black, or Hawaiian side, was restricted to the use of forces and means actually available, whereas the Blue Fleet had two constructive divisions of troops, represented by some 1,500 Marines.

"Black knew of the impending attack in ample time and estimated that Blue would seize a base on Lanai, one of the islands of the group, preparatory to launching an attack against Oahu itself. Black was in a difficult situation. No reinforcements could be expected and neither air forces, sub-surface nor fast surface vessels were available in sufficient strength to permit Black to deny any of the outlying islands to Blue.

"Blue's task was also difficult in that it involved an attack against a strongly fortified island some two thousand miles from Blue's nearest home base. Since a direct attack against Oahu was too hazardous, Blue planned to seize one of the outlying islands, Molokai, and to establish an air base there and to follow this with a naval demonstration against a bay on the south coast of Oahu for the purpose of diverting Black's attention. Blue then proposed to direct his main landing attack against the north coast of Oahu, while simultaneously therewith making a secondary landing on the west coast of Oahu.

"Blue made his dispositions accordingly. Blue was successful not only in seizing Molokai, but Lanai as well and in occupying the landing fields on both islands early on the 25th.

"Black anticipated that the main hostile attack would be launched against the West coast. With the forces at his disposal, it was physically impossible for the Black commander to have adequate local reserves on both West and North coasts, and to hold out general reserves.

"Confronting two attacks, one on the West coast and one on the North, he felt compelled to estimate one as the main attack and the other as secondary. The immediate consequences of a successful attack on the West coast were more serious than on the North coast. Therefore, Black placed the bulk of his forces so as to meet this attack. With adequate general reserves to meet any action of Blue, this risk would not have had to be taken. As it turned out, the bulk of the Black forces were too far from the North Coast of Oahu to repulse the major debarkation promptly.

"Blue's first move against Oahu consisted of a naval demonstration on the evening of April 26th. This was designed as a feint but did not have any practical result for it did not deceive Black for a moment and merely served to bring Blue ships under the fire of heavy Black batteries. Blue then launched his main attack against the North (or open) coast of Oahu on the 27th at daylight, landing troops under cover of and supported by heavy fire from his ships. The weather was ideal and there was practically no surf. The landing was vigorously opposed but the defense forces finally had to retire. Simultaneously with this main attack, Blue made a secondary landing on the west coast under cover of and supported by, heavy fire from his ships. Here considerable surf was encountered and the landing failed in face of the vigorous defense.

"It is of course extremely difficult to say whether either landing would have succeeded in an actual case. The local umpires on the spot were of the opinion that the landing on the north coast succeeded, Blue suffering severe losses, and that the landing on the west coast failed. Considering the two cases on their merits, I am of the opinion that the landing on the west coast would probably have failed in war, but that the landing on the north coast might well have succeeded. There is no doubt that highly trained, well led infantry can establish a beach-head once the troops are ashore. Even when the landings, as in the exercise, are well planned and covered by naval gun fire, the guns defending the beach will sink many boats, perhaps even transports.

Correction

THE title of the article, "Frankford Arsenal Ammunition Wins National Match Tests," by R. V. Reynolds, in the May-June issue of ARMY ORDNANCE, Vol. V, No. 30, page 817, was an obvious error. Mr. Reynolds' article describes the victory of Frankford Arsenal Ammunition in the Palma and International Match Ammunition Tests and the title should have read accordingly. In the case of National Match ammunition, this is determined by competitive tests between various lots of Frankford Arsenal ammunition and these tests had been previously fired.

We regret the injustice done Mr. Reynolds and Frankford Arsenal.

First Class U. S. M. A. Cadets at Aberdeen Proving Ground to see Modern Ordnance at Work

West Point Cadets at Aberdeen

MODERN Ordnance, its theory and its weapons, includes a vast category of subjects and covers an extremely broad field. The cadets at the Military Academy devote many hours of their senior year in a conscientious effort to solve the problems of Ordnance construction, and to understand such sciences as ballistics and such principles as hydro-pneumatic recuperation. In order that the theory they study and the descriptions they read may become more real and more tangible, it has been the practice for some twenty-five years or more to conduct the graduating class to an Ordnance Arsenal or Proving Ground so that the cadet might see in practical operation the processes that up to that time had existed only in theory. The class has just returned from the Proving Ground at Aberdeen where certainly an observer may see more of Ordnance in a limited time than at any place else in America.

Two hundred and thirty-five cadets under the supervision of Major Earl McFarland, Professor of Ordnance and Gunnery at West Point, reported to Colonel W. H. Tschappat, the Commanding Officer of the Proving Ground, Monday morning, April 27th. Colonel Tschappat welcomed the cadets and laid before them a plan for their two-day visit which was sure to be full of interest and which would certainly occupy their entire time. The program included work and play: demonstrations and lectures, big gun firings and airplane flights,—girls and a hop.

The first day was spent in the various buildings in which detailed descriptions were given of the instruments used for determinations of velocity, draw bar pull and the like. The instrument building afforded the cadets an opportunity to see in actual operation the Boulengè and Aberdeen Chronographs, both of these instruments having been studied in the class room. Here also were explained the latest theories on trajectories and projectile form, and the various apparatus and methods involved in the measurements of pressures, bore temperatures, recoil and counter-recoil velocities, and so on.

In the machine shop the cadets saw and had explained the various types of recoil brakes, the methods of determining draw bar pull, and here, also, they had an excellent view of the 14-inch Railway Mount, Model 1920, which was in the shops at that time for minor repairs.

At the ammunition shed explanations were given of the more recent developments in powder, projectiles, fuzes and primers. The new mechanical time fuze was demonstrated and a detailed description given. In the gage section were explained the causes of erosion with exhibits of both normal and abnormal bore conditions, by means of sectionalized guns and by wax bore impressions.

The museum was interesting to all because there the Cadet was afforded the greatest opportunity for comparison: the oldest tanks stand side by side with the latest developments, and the original pilot models of guns and equipment by the newest. It is always interesting, too, to observe the instruments of warfare used by an enemy, and the Aberdeen Proving Ground Museum is an ideal place for such observations, seeming to possess an example of every kind of tank, tractor, truck, gun and field carriage produced by Germany for the Great War.

A day entirely indoors, no matter how interesting, may become tiresome, and to overcome such a condition the cadets were afforded an opportunity of seeing the various guns of mobile type used on the main front. The types of experimental and service artillery, including small arms and machine guns, were inspected and explained. Of interest among these were the experimental 105-mm. howitzer, the Infantry mortar and the 37-mm. gun. Here also the cadets met "yaw," a rather obscure individual, and saw his tracks through the jump cards arranged down the range.

Perhaps the most enjoyable hour of this day of instruction was the operation and features of modern motor carriages, tanks, tractors and trailers now or recently under test. The cadets were given an opportunity to ride on several of these machines and to drive others. As the weather prohibited the scheduled airplane flights, a rea-

sonable effort was made by members of the class to get their excitement from a flying Ford.

The last hour of the afternoon was taken over by Major A. W. Ford, who gave a very comprehensive talk on "Testing Guns and Ammunition," giving in order the steps followed in carrying out tests from the time the article is received at the Proving Ground until it is turned over to the using services.

The officers and ladies of the post being firm believers in the old adage that "all work and no play, etc.," gave a delightful reception and dance in the evening.

The second day began with a lecture by Major G. M. Barnes of the Ordnance Office on "Recent Experimental and Development Work of the Ordnance Department." The reaction from this talk indicates that the cadets were more concerned with the engineering features of autofrettage than any other advances in ordnance design, and that the class will watch the possibilities and use of this new type of gun construction with great interest.

Major H. R. Kutz's lecture on "Storage of Ordnance Material and the Ordnance Supply System" was of exceptional interest due largely to the instructive lantern slides shown in connection with the lecture and to the very clear explanation of what they were about: of how to store and ship, and how *not* to store and ship. Many cadets have never had the opportunity of seeing storage of artillery and ammunition in large quantities, and these conditions were brought out admirably by the slides.

At the plate range the cadets saw and had explained to them the 16-inch Barbette gun from which one round was fired. This gun was of the Navy type which is somewhat different from the Army type which the cadets had studied. One round was also fired from the 12-inch howitzer railway mount. Here the cadets had pointed out to them the manner in which the screens were rigged for determination of velocities of seacoast cannon. Two 600-lb. bombs were dropped for water impact. At the aviation field the cadets inspected exhibits of foreign and domestic bombs, with which there was an explanation of various types of bombs, fuzes and bomb testing equipment.

On Tuesday afternoon, Major J. H. Burns gave a most interesting lecture on "Nitrates," including the Muscle Shoals angle of the nitrate situation. The remainder of the day was given over to practical demonstration of artillery and small arms which included firing of the Browning Machine Guns, .30 and .50 caliber, at small balloons, the new 37-mm. automatic gun, the 37-mm. M1916 using supersensitive fuzes firing at airplane wings, the 105-mm. howitzer, Model 1920, and 3-inch antiaircraft gun, Model 1917. An outline of a trajectory using the 75-mm. Model 1897 gun was attempted, but due to the low hanging clouds and poor visibility, only the bursts nearest the gun were seen. This same gun was fired to give comparisons of the black, service and flashless powders. This latter, with the previous firing against small balloons and the following firing using 3.3-inch modified 5-inch guns for stability, were quite the most interesting periods of the afternoon firing.

The third day of the trip was spent at the Chemical Warfare Service plant at Edgewood Arsenal, and at Fort Hoyle. While at the Arsenal a visit was made to the plants manufacturing gas masks, phosgene, chlorine, chloracetophenone, mustard gas, etc. The remainder of the forenoon was gives over to a review of the 1st Field Artillery Brigade, and to visiting the stables and barracks of the 6th Field Artillery.

After luncheon the cadets witnessed a demonstration of field artillery firing by the 6th Field Artillery, a problem being presented and solved, giving adjustment and fire for effect, and an artillery smoke screen. A smoke curtain was effectively laid down by the Air Service.

The students having previously been equipped with gas masks, were treated to tests of these by walking through lachrymatory and other gases. There was also a demonstration of Livens projectors, Stokes trench mortars, hand grenades, smoke candles and sectionalized chemical warfare material.

The final day was spent at Frankford Arsenal and enroute to West Point. At Frankford, the cadets found the manufacture of small arms ammunition particularly interesting, and were greatly impressed by the accuracy of work and the large variety of operations performed on the bullets that they had so thoughtlessly fired by the thousands. They had read of automatic machines, but it was a revelation to see the almost human performance of the gears and wheels and cams of the small arms manufacturing equipment. While here the class visited the instrument department, observing the latest types of listening device and sound range finders, plotting boards, fuze setters and other Frankford devices. The work as carried on by the optical shop was of interest, the cadets seeing glass and lens grinding, polishing and cementing, and final testing of instruments. These few hours at Frankford gave quite a new idea of modern manufacture.

The West Point Class of 1925 was graduated on June 12th. Of Ordnance, the class has had an instructive year of design, computation, description and explanation. The few days at the Proving Ground showed the practical side of the section room work and gave the cadet a fuller appreciation of the application of engineering theory, and a truer conception of the size of the Ordnance task and the problem of its manufacture and supply.

DON'T FORGET!

SEVENTH ANNUAL MEETING

OF THE

ARMY ORDNANCE ASSOCIATION

ABERDEEN PROVING GROUND, OCTOBER 2, 1925

Red and Yellow Ammonium Picrate

By

DR. G. C. HALE

DIFFERENT lots of ammonium picrate manufactured for the Ordnance Department during the War varied in color from a clear lemon yellow to a deep orange red. Since all the ammonium picrate used previously was yellow in color and the specification covering the material prescribed such a color, the question arose as to whether the red-colored material was of inferior quality and should be rejected for use in loading shell. A sample of the red material was sent to Picatinny Arsenal for examination as to its explosive properties, and for comparison with the standard yellow variety.

A chemical examination showed the red material to comply with the specification for ammonium picrate in all respects except for the abnormal color. Further tests showed that the red variety could be converted into the yellow by special methods of recrystallization. The temperature required to effect spontaneous explosion of the two samples was found to be the same and the sensitivity to impact of no measurable difference. When the two varities of picrate were loaded into copper capsules and detonated in the standard sand test, the same amount of tetryl (within the limits of experimental error) was required to effect complete detonation in each case, thus showing that the sensitivity of the two forms of detonation by initiators was practically the same.

Fragmentation tests were also carried out on two series of 3-inch steel shell loaded respectively with the red and yellow picrates. The explosive was pressed to the same density in each of the shell and fired in the same manner in the fragmentation chambers at the Arsenal. This test was the first to reveal any difference in the explosive properties of the two samples. The average number of fragments obtained from five shell loaded with the red picrate was about 15 per cent greater than the number obtained from the yellow picrate. This test was later carried out on two other samples of red picrate from different lots and again more complete fragmentation of the shell was obtained than was the case with the yellow material. This indicated quite conclusively that the red picrate possessed greater brisance than the yellow. Since the tests just referred to indicated that the red picrate was in no wise inferior to the yellow variety, the specification covering the purchase of ammonium picrate was changed so as to permit the acceptance of the orange-red material and the use of it in loading shell.

As a possible explanation for the difference in the strength or brisance of the red and yellow picrates, it was suggested that although both varieties are formed by endothermic reactions and have high negative heats of formation, the red variety may have the higher negative heat of formation; if this is the case, the red material would liberate somewhat more energy upon explosion than the yellow, provided the products of the reaction were the same.

If the red picrate has the higher negative heat of formation, it might be expected to have less stability than the yellow material, but it is by no means necessary to assume that the difference in the heats of formation would give rise to such a difference in the stability of the two materials, that it would be of practical significance in using the red picrate as a filler for shell. As a matter of fact recent surveillance tests on the two varieties of ammonium picrate have shown that after many months storage at 50°C., the one is not appreciably different from the other in either stability or sensitivity. The surveillance tests are being continued, however, and it may be that in time some difference in the stability of the samples under test will develop. Therefore in summarizing it should only be said that *up to the present time* no difference in the chemical or explosive properties of the two picrates has been detected except for the higher brisance shown by the red variety.

Innate curiosity, if nothing more, leads one to inquire into the cause for the difference in color possessed by different samples of the same chemical compound. This question has received the attention of chemists for many years and several interesting theories have been developed to account for the intricate phenomenon. Using certain facts which have been established in studies of red and yellow ammonium picrate, together with certain theories that have been advanced to account for variations in the color of chemical compounds in general, an attempt will be made here to develop a plausible theory for the two colors of ammonium picrate in particular.

According to the physicist, sunlight is not homogeneous, but consists of various colored constituents as revealed by the spectrum, and the color of any body, when viewed in sunlight, is due to the capacity of the body to absorb some of these colored constituents of sunlight; the constituents not so absorbed are diffusively reflected and form the ocular image of the body. Thus, if sunlight falls on a crystal which is so composed that it will absorb all of the constituents of the light, except those which form the red end of the spectrum, the red constituent will be diffusively reflected and on reaching the eye will give rise to a red image of the crystal. Hence the color of the crystal is red.

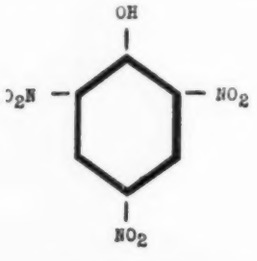
This, however, does not explain how or why crystals of different compounds reflect different constituents of the sunlight to yield the variety of colors that the compounds possess. Graebe and Liebermann were perhaps the first to observe that the absorption of light and hence color are dependent on the chemical constitution of the colored body. Since that time it has been shown that by substituting many groups and radicals in organic com-

pounds, the absorption of light can be shifted from one end of the spectrum to the other. Witt[1] in an extensive research established the general effect of such chemical groups or radicals on the color of organic compounds. He called such groups "chromophores," a term in general use at present. He found that certain groups other than chromophores had a marked effect in intensifying the color of dyes and applied the term "auxochrome" to them. Some of the more intensive chromophores are the nitroso group —N=O—, the azo group —N=N— and the thio group —C=S—. Among the common auxochrome groups are the amino group, NH_2, and the hydroxl group, OH.

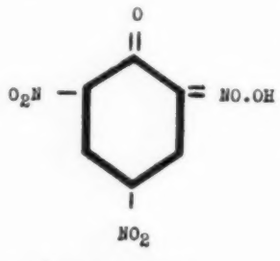
Pure nitroso compounds are strongly colored whether aliphatic or aromatic; as examples, nitrosobutane and pentane are deep blue while nitrosobenzene and derivatives are green. The Nitro group is also a chromophore but not as strong as those mentioned above; thus all nitro paraffins are colorless while the nitro aromatic compounds are only weakly colored unless the compound contains an additional chromophore or an auxochrome group. For example trinitrobenzene which contains no chromophore but the nitro groups, is only slightly colored, whereas picric acid which contains an hydroxyl group (an auxochrome) as well as three nitro groups is strongly colored and has long been used as a dye.

While Witt's theory of chromophores is found to apply to a large number of chemical compounds, Hantzch[2] has pointed out that it will not explain all cases. Hantzch showed that many compounds of acid character were colorless while the salts are colored. p—Nitrophenol for example is colorless while all of its salts are yellow. Hantzch showed further that as a general rule the change of such colorless organic compounds into highly colored salts is attended by a modification of constitution affecting a chromophoric group. He also studied numerous compounds each of which may possess more than one color and applied the term "chromoisomer" to them.[3] Ammonium picrate, thallium picrate, methyl orange and aminoazobenzene are examples of compounds which have two isomers distinguished by color. A few cases of tricolored isomers are also known. Hantzch presented the view that such chromoisomers are the best supports for a chemical theory of color change.

More recently Dehn and Ball[4] have studied the two varieties of salts of picric acid and concluded that the changes of color of both picric acid and its salts can best be explained by assuming that picric acid exists in two isomeric forms of different color and that these isomers can be transformed by various influences such as water, alkalies or acids, and heat. The isomers of picric acid were represented as follows:



Benzoid isomer



Quinoid isomer

The benzoid isomer of picric acid is colorless, while the quinoid isomer is yellow to red. Dehn and Ball point out that there is much evidence to indicate that solutions of picric acid and of its dry salts may exist as equilibrial mixtures of the two isomeric forms. This equilibrium can be disturbed by any one of three conditions, viz., concentration, heat and alkalinity. Marchwald[5] found that picric acid was colorless when dissolved in non-dissociating solvents, while Bortini[6] showed that if water is added to anhydrous solutions of the acid such solutions acquire a more intense color. Dehn and Ball state that heating an aqueous solution of picric acid causes a darkening of color, and that a similar effect is produced by melting dry picric acid or heating its salts.

Chamot, of Cornell University, in an interesting report to the Chief of Ordnance brought out the following points among others as having been established in his work on red and yellow ammonium picrate.

1. In preparing ammonium picrate from picric acid and ammonium hydroxide the picrate became more darkly colored as the concentration of the hydroxide and the temperature were raised. Under no conditions was a uniformly colored, homogeneous red ammonium picrate obtained. Fractional recrystallizations of the red picrate from concentrated ammonium hydroxide failed to yield darker or more homogeneous red crystals.

2. At elevated temperature, 150°C., the red crystals change to the yellow variety.

3. Picric acid was purified by repeated fractional recrystallizations. The middle fractions were combined and again fractionally recrystallized. The middle portion of the last fractionation was treated with boiling ammonium hydroxide in excess; red picrate crystals were formed. This proved that the red color of the picrate was not due to any impurities in the picric acid.

4. When red ammonium picrate was recrystallized from water containing free picric acid, only yellow crystals were obtained.

This work substantiates the conclusion of Dehn and Ball, that the chromoisomers of ammonium picrate exist as equilibrial mixtures, either in solution or in the dry state, and that this equilibrium can be disturbed by variations in the conditions of concentration, heat and alkalinity.

It would seem then that the assumption of two chromoisomeric forms of ammonium picrate, each of which can be changed readily into the other by various conditions, is in accord with experimental data. While it has been explained by Ostwald that such changes, from one color to another, of chemical compounds is due to ionization, this is not sufficient to cover this case, for ionization cannot account for the fact that red ammonium picrate can be changed to the yellow variety by simply subjecting the dry red salt to elevated temperatures. In numerous other cases also it has been found that the specific light absorption is characteristic of the salt and not merely of the ion.

If it is accepted that the theory of chromoisomers in ammonium picrate offers the most plausible explanation

1Ber. 9 p. 522 (1876).
2Ber. 32 (1899), p. 583, 3085.
3Zeit. Angew. Chem. 20 (1907), p. 1889.
4Zeit. Angew. Chem. 39 (1917), p. 1381.
5Ber. 33, 1900, p. 1128.
6Zphysik. Chem. 87, 104, 1914.

for the existence of the red and yellow forms, there still remains a question as to the internal changes in the structure of the molecule which enable the chromophoric groups to act so effectively.

The theory of chromophores affirms an observed connection between certain constitutions and color, but it does not explain why the benzoid and quinoid isomers of ammonium picrate should absorb different colored constituents of sunlight; it merely affirms that they do and leaves to the imagination the true connection between light absorption and the inter—or intra—atomic structures which give rise to the space lattice of the picrate crystals. It would seem that there must be a difference in the internal structure of the red and yellow picrate crystals or there could be no difference in the light absorption which causes the difference in color. The theory of chromophores implies such a difference in structure perhaps, but does not explain the difference.

According to modern theory, all light waves are vehicles of energy, and when the waves of sunlight penetrate a crystal this energy is dissipated in various ways. If the period of a portion of the waves is equal to the free periods of the electrons which make up the atoms of the crystal, the electrons will be set in violent vibration and will absorb energy. Thus the sunlight is robbed of the waves agreeing in period with those of the electrons and absorption of the light is said to have been effected. The other waves of the light which do not agree in period with the electrons are not absorbed but are partially reflected from the surface of the crystal and also from a succeeding series of planes of molecules or atoms parallel to the face. This reflection as mentioned previously accounts for the color of the crystal. Portions of the waves are neither absorbed nor reflected but are transmitted ordinarily without appreciable refraction or diffraction through the crystal. When X-rays instead of sunlight strike a crystal the wave length of the X-rays is so short, as compared to the waves of sunlight, that appreciable diffraction of the X-ray waves results. Reflection of the X-rays at the crystal surface and at the series of planes also occurs the same as with sunlight.

J. Stark in a comprehensive theory has assumed that it is the semi-detached or labile electrons which play the most important part in absorption phenomena. Benzene is said to posses the labile electrons, and their presence is indicated in such chromophores as the nitro group, the nitroso group and the diazo group. It has been assumed that the relative degree of detachment of such labile electrons is not constant but is dependent upon various influences, such as the introduction of another chromophore in the molecule, etc. When the lability of the electrons is increased it has been observed that the substance absorbs longer wave lengths of light. This would mean according to the above theory that the period of the waves comprising orange and red light is more nearly in agreement with the free period of the more labile electrons.

While so far as known Stark did not apply his theory to compounds such as ammonium picrate which may possess two colors, it is believed that his theory together with the chromophore theory offer the most plausible explanation of the color effects observed with the picrate. This theory might be summarized as follows:

In ammonium picrate two chromoisomers exist; the benzoid isomer is colorless; the quinoid isomer is yellow to red. Since the atomic linkage of the quinoid isomer is different from that of the benzoid, it may reasonably be assumed that either the number of labile electrons or the relative degree of detachment of these electrons is greater in one isomer than the other. If there is a difference in the number or degree of detachment of the labile electrons in the two isomers then the isomers will absorb different light waves or at least the same waves to a different extent; the benzoid isomer has few or no labile electrons and hence does not absorb light and is colorless. The quinoid isomer has labile electrons the free period of which agree with the period of the shorter light waves; hence the long waves are not absorbed but are reflected and the picrate crystal appears yellow to red. The shifting of the color of the picrate from yellow to orange to red is a result of influences which partially control the degree of detachment of the labile electrons. Such influences as heat, alkalinity and concentration have been found experimentally to cause the change of color.

This theory will account for the fact that many single crystals of ammonium picrate are yellow in the interior of the crystal and red at the outer edges or over the outer surface. When crystals are formed in a solution they are not formed instantaneously of a particular size but are built up gradually, atom on atom and perhaps molecule on molecule, until a crystal of considerable size results. When the last layers of atoms are applied to the crystal the concentration of the solution, and in practically all cases the temperature of the solution, is appreciably different from that when the crystal first began to grow; this difference in concentration and temperature is no doubt sufficient to influence the nature of the labile electrons in the atoms of the crystals. The atoms which serve as the foundation in building the crystal structure are therefore of one color while those applied later to the crystal are of another. So far as known no study has been made of the internal structure of ammonium picrate crystals by means of X-rays. Such a study would be of interest as it would probably reveal whether the spacing of the atoms in the red picrate crystal is different from that in the yellow. The conclusion on this point would assist in judging the reasonableness of the above theory of the red and yellow varieties of ammonium picrate.

Development of the Cross-Country Car

By

MAJ. GEORGE SCHUSTER, ORD. RES.

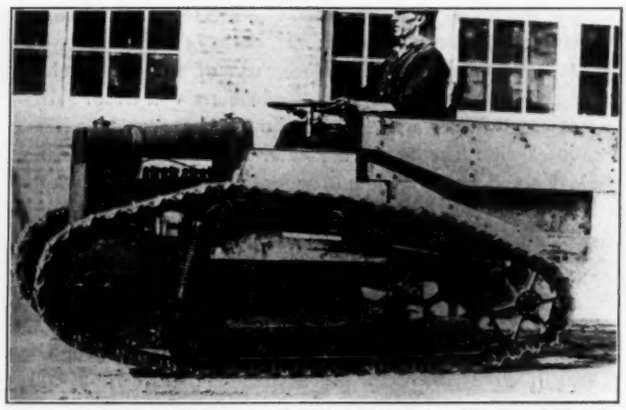


Fig. 1. Experimental Reconnaissance Tractor, with Metal Track

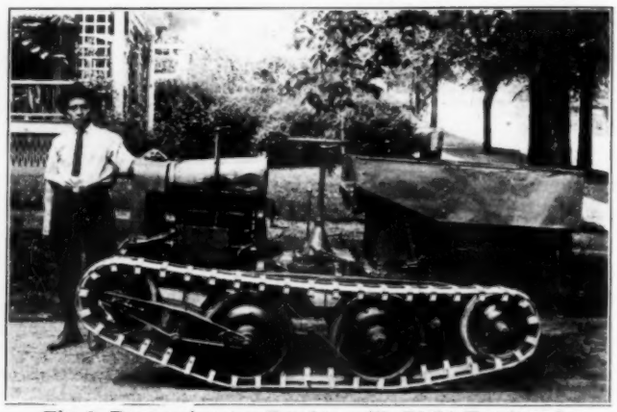


Fig. 2. Reconnaissance Tractor, with Light Track and Water Cooled Engine

THE World War demonstrated the great need of a passenger vehicle for cross-country service; *i. e.*, the motorization of the individual man. To complete the motorization of artillery organizations, it was felt that some type of automotive conveyance was necessary to replace the horse of the individually mounted man for use in reconnaissance for pack transportation, for transportation of ammunition and for many other purposes.

It is the purpose of this article to outline the steps that have been taken by the Ordnance Department in solving this problem and to show the development of various vehicles for this purpose. It will be shown that during the development the vehicle was necessarily modified from time to time by the changing conditions and equipment, and that time and development tests greatly modified the original specifications.

As the tests and development progressed it became apparent that all of the original specifications could not be met in a single vehicle because of the compromise necessary in the construction to meet the many operating conditions thought necessary.

The original specifications of this type vehicle were contained in the Caliber Board Report in 1919. Its purpose was to provide automotive equipment for the motorization of the individual man and to include a limited amount of cargo capacity. As the vehicle was primarily intended for cross-country purposes, it was quite natural that the first effort should be along the lines of the tracklaying tractor that had been found satisfactory for cross-country service.

One of the first vehicles constructed in accordance with the original specifications is shown in Fig. 1.

In this construction the tractor influence is clearly shown and the vehicle was designated as a "reconnaissance tractor." Metal tracks were used together with a modified form of track roller frame similar to the then current tractor running gear construction. It was intended to have the cargo capacity 500 pounds, including operators, the completed vehicle alone to weight about 1000 pounds.

When completed it was found that the weight was far in excess of this figure due to the heavy track and running gear, so that for cargo purposes the pay load was small in comparison with the weight of the vehicle. In addition the vehicle was not adapted for operation in water or, at least, not for operation in water of fording depth which was one of the requirements. The speed was too low for an effective reconnaissance vehicle.

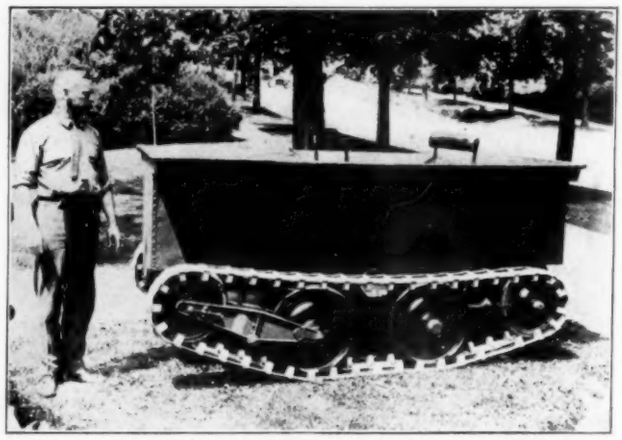


Fig. 3. Reconnaissance Tractor with Air Cooled Engine

Accordingly an attempt was made to modify this vehicle —first to reduce weight, second to increase speed, and third to make vital parts waterproof.

The result of this modified reconstruction is shown in Fig. 2. The track was changed to the flexible fabric band type with metal cross cleats and was driven by lugs on the drive wheel. The running gear was changed from the conventional tractor truck frame to a series of rubber tired wheels mounted on leaf springs. Operation in water to the depth of the height of the vehicle was provided for by enclosing vital parts in watertight boxes; the air inlet to the carburetor was through a standpipe above the engine.

While the construction as shown reduced the weight to about 1700 pounds the vehicle was not satisfactory for a number of reasons. The water-proofing did not prove satisfactory because retained moisture effected the operation of parts when not operating in water.

There was considerable difficulty with and repeated failure of power plant due to the heavy load imposed by the track and running gear. The track drive was not positive and as a result the vehicle could not moor under certain

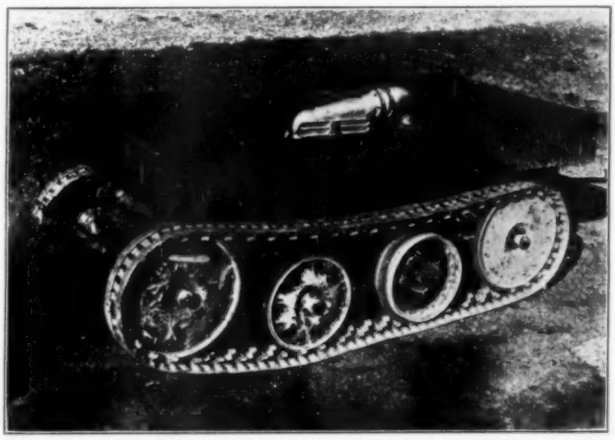


Fig. 4. Reconnaissance Tractor with Modified Running Gear

ground conditions. There was still too much vehicle for the pay load.

In a second model an attempt was made to improve the vehicle with the construction shown in Fig. 3. The body was completely enclosed with water-tight joints. The motor used was air cooled. The track construction had the characteristic angle of approach and angle of departure necessary in vehicles for cross-country service. Enclosing the power plant, transmission and associated parts in a water-tight hull was thought preferable to water-proofing the individual parts. The water-tight hull made it possible not only to ford shallow water, but to float in deep water.

Another vehicle of similar design is shown in Fig. 4. The general appearance is similar to Fig. 3, but it embodied some improvements in the running gear. A wide flanged wheel on each side was used in an effort to keep the track from being thrown under certain conditions of operation.

The power plant was an air-cooled motor. This vehicle also had a water-tight hull and could float. The track was made up of fabric bands and steel cross cleats.

As a result of tests and observation of performance of this series of vehicles, an effort was made to produce a final type that should meet all the demands of the using services, and to incorporate all the improvements found necessary by test. As a result two sizes of reconnaissance tractors, 800-lb. and 1600-lb., were built and tested. One of these is shown in Fig. 5.

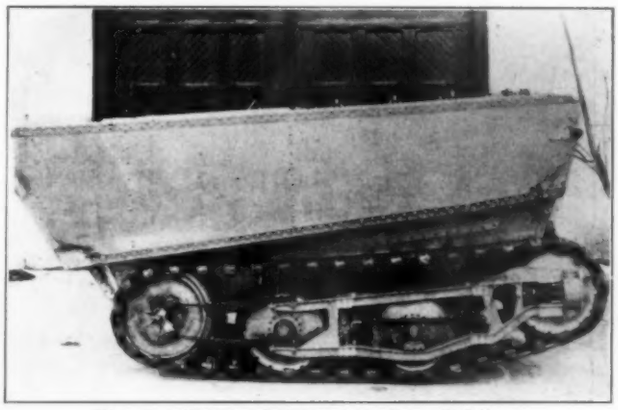


Fig. 5. Reconnaissance Tractor, 1600-lb.

The bodies of these cars were made of duralumin and were water tight for operation in water. A propeller, operated by the engine of the vehicle, was provided at the rear. Prior vehicles were made to float in water, but had no provision for propulsion and steering in water. There was also a rudder for steering. The propeller and rudder were placed in a depression in the body at the rear for protection when operating on land.

The track was of the band and metal cross cleat type and was driven by lugs on the drive wheel at the rear. The running gear with the spring suspension was of novel design and was arranged to give the maximum flexibility and comfort in riding over cross-country ground conditions.

The front end of the body was closed with a water-tight door to keep splash out of the engine compartment

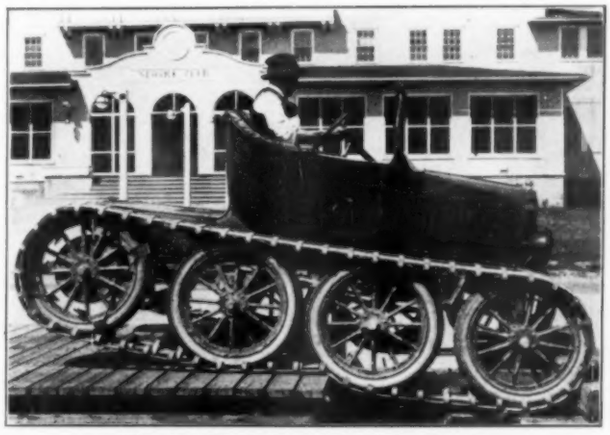


Fig. 6. Ford Car with Light Track

when operating in water. The power plant consisted of a commercial air-cooled motor with an S. A. E. rating of 16.89 H. P. The transmission consisted of a gear set and steering clutches for steering as in the conventional track-laying tractor. A clutch was provided for engaging the propeller shaft for operation in water.

Generally, while this vehicle followed the early experimental models, an effort was made in this design to make a finished product complete in every detail and to incorporate all the improvements found necessary by test.

Tests at the Aberdeen Proving Ground and by the using services with this type of reconnaissance tractor demonstrated that too much had been attempted in one vehicle, with the result that the compromise in design that had to be made resulted in a combined type of vehicle that was not satisfactory either as a land vehicle or for service in water.

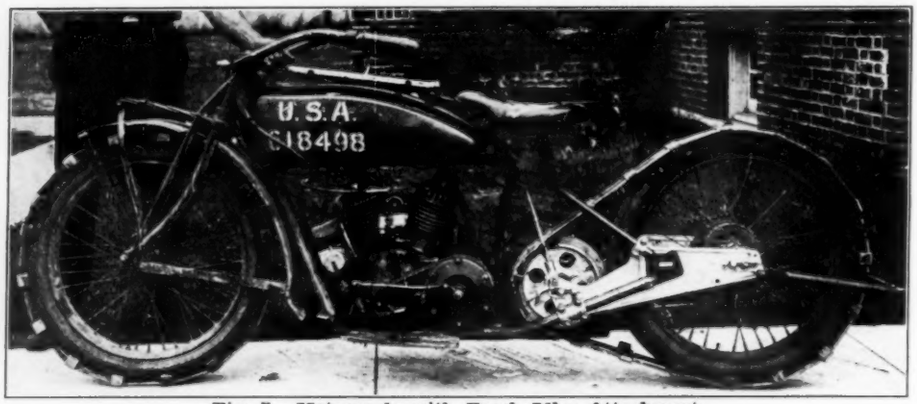


Fig. 7. Motorcycle with Track Idler Attachment

The tests also demonstrated that the fabric track with metal cross cleats was not satisfactory for extended service, and that the method of driving the track by lugs on the drive sprocket was not positive enough to insure traction under all conditions. For instance, when climbing an abrupt slope or passing over an obstacle, a condition requiring positive engagement of the driving sprocket with the track, the actual result was that the driving sprocket revolved within the track without moving it. When operating in water, the propeller, due to the location off-center, had a tendency to drive the vehicle in a circle. The road shock and vibration soon loosened the riveted joints of the duralumin body with the result that there was leakage of water into the body. While some of these defects could be remedied by changes in construction, an important defect brought out by the tests was the entire lack of a suitable type of light track for vehicles of this class. Not only was the construction too frail for extended service, but the method of drive was not positive. Generally, the effort to combine a land and water vehicle was not successful, and the tests quite clearly demonstrated the impracticability of the idea.

Another application of a light fabric track, in this case to a car in production, is shown in Fig. 6.

Here again an effort was made to secure cross-country mobility by the use of a track, the construction being similar to the type used on the reconnaissance tractor referred to above. In this case the effort was made to modify a passenger car by adding wheels to distribute the load over the track. Steering was accomplished by replacing the brake drums with larger drums, each brake being applied separately from the driver's seat. The differential, with the use of the individually operated brakes, provided the means by which either track was stopped to effect turning.

The fault in this vehicle was in the track construction which failed because it was not durable enough. There was also the problem of drive of the track. Metal lugs were bolted to the rear wheels for driving the track. This arrangement did not give a positive drive and there was much slippage under certain conditions of operation.

As will be noted in the illustration, pneumatic tires were used on all vehicles, and these were inflated to the usual pressure for the size. The passage of the steel straps or cleats of track over the tires, together with the slippage, caused much wear on the tires, and as a result they failed very rapidly.

The motorcycle was not overlooked in the effort to secure a satisfactory one-man conveyance for cross-country service. Fig. 7 shows the result of an effort to adapt a commercial motorcycle to this service by the addition of an idler ahead of the rear wheel with modifications in the frame to adapt a light fabric track over the idler and rear wheel as well as a track over around the front wheel. Tests with this arrangement showed that the track was an incumbrance rather than a help since it made steering very difficult and made a hard riding cycle; in addition the mobility was not increased over the standard cycle with chains on the wheels.

Fig. 8. Aberdeen Cross-Country Car, Ford Chassis

The rapid wear and early failure of the rubber tires when used with such a track has been a characteristic failure of this type of construction wherever employed on experimental vehicles. All efforts to adapt a track to a motorcycle have been definitely abandoned. An interesting

adaptation of this type of track where there was rapid failure of tires due to the action of the track parts on the rubber was the Dodge Light Repair Truck, to which this track had been applied.

The Dodge Light Repair Truck was equipped with a fabric track using a running gear of both 6 and 8 wheels. In the 8-wheel construction the track passed over all four wheels on each side, similar to the Ford Car shown in Fig. 6, while in the 6-wheel construction the track passed over the two wheels at the rear, while the front wheel had a track around it and was used for steering in the usual manner.

Another serious effect resulting from the application of light tracks and modification to running gear by adding additional wheels and rigging to convert a wheeled vehicle into a tracklaying vehicle, is the effect on the power plant. It has been found that the wheeled vehicle, which ordinarily satisfactory for a reasonable life while operating under the load requirements of the wheeled vehicle, does not have a satisfactory life when the vehicle is converted into a tracklaying type. The additional load caused by increased friction losses in the track and additional wheels, demands a higher average power output with the result that the engine and transmission parts fail earlier. This is especially true in the case of tracks similar to the belt and cleat type, where there is a high power loss due to flexing of parts.

Tests and study of the various types of light track vehicles resulted in modified views regarding the type of vehicle necessary for this class of service. The adaptation of light tracks to commercial cars did not result satisfactorily for the reasons noted, and it became apparent that the essential requirement of low unit ground bearing pressure for cross-country cars must be accomplished in some other manner than a makeshift light track such as had been tried.

As a result of these observations there was conceived at the Aberdeen Proving Ground, late in 1922, the idea of gaining the low ground bearing pressure by using low pressure tires of large cross-section and by reducing the weight of the vehicle to a minimum by stripping of all but essential parts.

As the commercial balloon tire had not yet been well developed, the first car built in accordance with this idea was equipped with airplane tires. The car is shown by Fig. 8.

As will be seen, a standard stripped Ford chassis was used with the wheels modified so as to take D H Airplane Tire 900 by 200-mm.

The Ford transmission was retained and supplemented by a Warford auxiliary gear set, with three speeds which, with the regular transmission, gave a wide range of speeds, six forward and two reverse.

Fig. 9. Dodge Cross-Country Car

Bucket seats, both facing forward, replaced the standard body. The gas tank was in rear of the seats and above the frame. Canvas fenders were used to replace the regular steel fenders. There was no windshield and no protection of any kind, as there was no intention to provide any more protection than a rider on a horse has. In this stripped condition the car weighed 1400 pounds.

After some 1500 miles of testing at the Aberdeen Proving Ground the tires were changed to 30 by 5-inch size on disc wheels. The large airplane tires had smooth treads and these did not have satisfactory holding power. In addition the large tires, 8-inch diameter, made steering difficult.

As a result of tests with the first car, a second Ford Car was made up with some changes. Among these were the retention of the regular steel fenders, four bucket seats instead of two. The tires were the same as on the first model, 30 by 5-inch. The weight of this car was 1510 lbs.

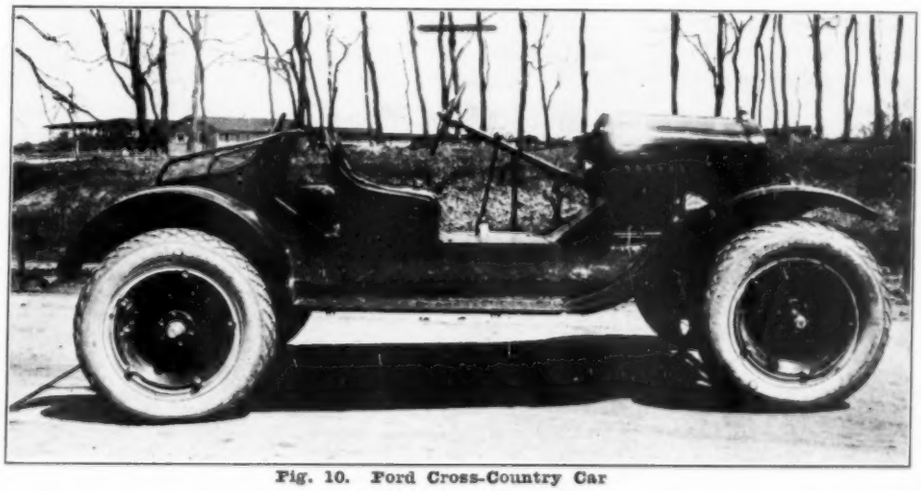


Fig. 10. Ford Cross-Country Car

At the same time, a Dodge Car was stripped and equipped as shown in Fig. 9.

This vehicle was made up to be tested in comparison with a Ford in view of the more powerful engine of the

Dodge and the fact that the low speeds were obtained without the addition of an auxiliary transmission.

This Dodge Car had 7.5-inch tires on 20-inch disc wheels. The windshield was retained; two bucket seats were fitted. The weight of this car was 2115 pounds.

For experimental purposes, the auxiliary equipment on these cars, such as transmission, type of body, arrangement of seats, location of spare tire, bumpers, shock absorber and other items have varied on the different cars built to date.

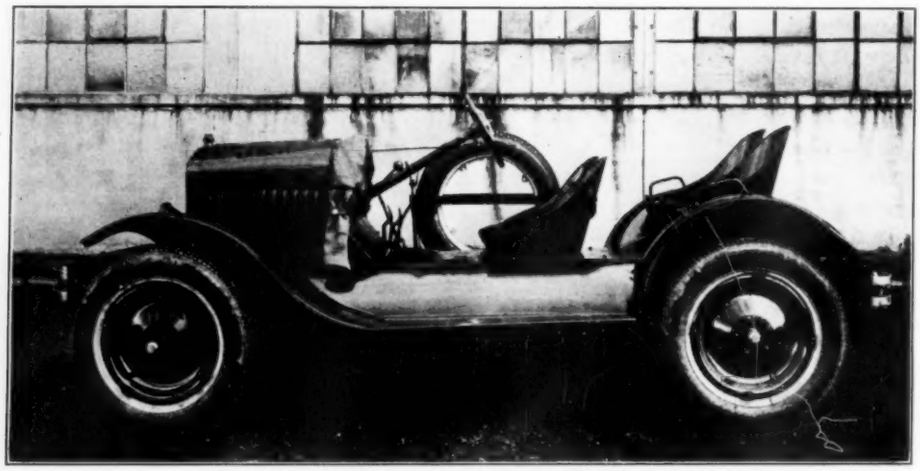


Fig. 11. Latest Type Ford Cross-Country Car

Subsequent tests with the Dodge Car indicated that while more powerful, the greater weight and longer wheel base were decided disadvantages in cross-country service.

The first Ford Cross-Country Car turned over to the using services for test was that shown in Fig. 10.

This car, together with the first Ford Car assembled and the Dodge car were driven to Fort Bragg and Fort Benning in May, 1924, by personnel from the Aberdeen Proving Ground. At each of these places the cars were demonstrated before the Service Board by experienced drivers who operated the cars fully loaded over very difficult ground conditions to demonstrate the wide conditions of service that could be expected from vehicles of this type.

The car shown in Fig. 10 was left with the Field Artillery Board at Fort Bragg for a more extensive test.

So satisfactory has been the performance of these cars that their appearance has resulted in numerous requests for similar cars. Since the first cars were made up, a number have been similarly equipped and sent to the using services for test. The Infantry Board at Fort Benning has been supplied with four cars for test. The Field Artillery Board at Fort Bragg has two and the Tank School at Camp Meade has two. In addition to these, three cars are to be furnished the Field Artillery School at Fort Sill and three to the 83rd Field Artillery Regiment at Fort Benning.

As a result of tests and observation of performance of the first cars constructed, the equipment and general arrangement for cross-country cars is shown in Fig. 11. The three cars for the Field Artillery School at Fort Sill and the motorized 83rd Field Artillery Regiment at Fort Benning are being made similar to that shown in Fig. 11.

The development of the Cross-Country Car has now progressed to a point where there is available in quantity a very satisfactory vehicle for this service. As it stands today, it is radically different from the first car constructed for this purpose. The tracklaying type thought necessary for this purpose was found unsatisfactory for these vehicles, and the more desirable round wheel, balloon tire equipment has been developed. It has lost its name "reconnaissance tractor" and become "cross-country car." It can be used as a cargo carrying vehicle by removing the rear seats and fitting a box for cargo. It has, due to its low weight in comparison with its tire size, excellent cross-country mobility. Thus, by the utilization of commercial equipment in production a difficult problem has been solved in a simple way, and what was at first considered as requiring a special type of tracklaying vehicle is found to demand only the application of special features to commercial equipment at hand, which is available in quantity production.

Death of Capt. C. A. Watkins, Ord. Dept., U. S. A.

AS this issue of ARMY ORDNANCE goes to press, word has just been received of the drowning of Capt. C. A. Watkins, Ord. Dept., U. S. A., and his family consisting of wife, five-year-old daughter, and two-year-old son, on July 3, 1925. The accident occurred at the Leesburg Ferry, Cherokee County, Ala., a crossing of the Coosa River.

Captain Watkins, a member of the Army Ordnance Association, had been stationed for several years at Headquarters, Fourth Corps Area, Atlanta, Ga., in connection with activities of the Organized Reserves.

We regret our inability to give further details at this time. Captain Watkins' death marks the passing of an officer who was greatly interested in Reserve Officer training and whose record of service during the World War and since was most meritorious.

The Influence of Temperature on the Detonation of Ammonium Nitrate*

By

D. B. GAWTHROP

THE work herein reported represents the fifth phase of the general investigation on the explosibility of ammonium nitrate, conducted by the Explosives Section of the Bureau of Mines under the direction of the National Research Committee. So far, the five papers listed below[1] have been published.

This paper gives the results of experiments to determine the rate of detonation, extent of propagation of explosion, effect of boosters, and the effects of temperature on the rate of detonation of ammonium nitrate under certain definite conditions of density of loading, diameter of charge, confinement of charge, and size of materials.

Previous investigators appear to have neglected this phase, as a search of the literature resulted in very little being found on the rate of detonation of ammonium nitrate. Aufschläger[2] gives some information but not of a definite nature.

He states that the rate varies from 1270 to 2460 meters per second, depending upon the booster, confinement, and diameter of charge used. No other references pertaining to the rate of detonation of ammonium nitrate have been found.

Materials Used in Tests

The materials used in these tests were from the same lots as used by Sherrick and Jones, and some details are as follows:

Ammonium Nitrate.—This was designated as "B. A. S. F. 550" ammonium nitrate, and was given for tests by the Hercules Powder Co. It was dried and stored in glass jars. Analysis is as follows:

Constituent	*Per cent*
Moisture	0.38
NH_4Cl	.03
Fe_2O_3	.09
Insoluble	.04
NH_4NO_3	99.46
Sulphates, thiocyanates, nitrites, nitrides, oils	None

A screen test on the dried ammonium nitrate is as under:

Mesh	*Per cent by weight*
On 10	1.7
On 10 to 20	57.7
On 20 to 35	37.0
On 35 to 48	2.8
Through 48	0.8

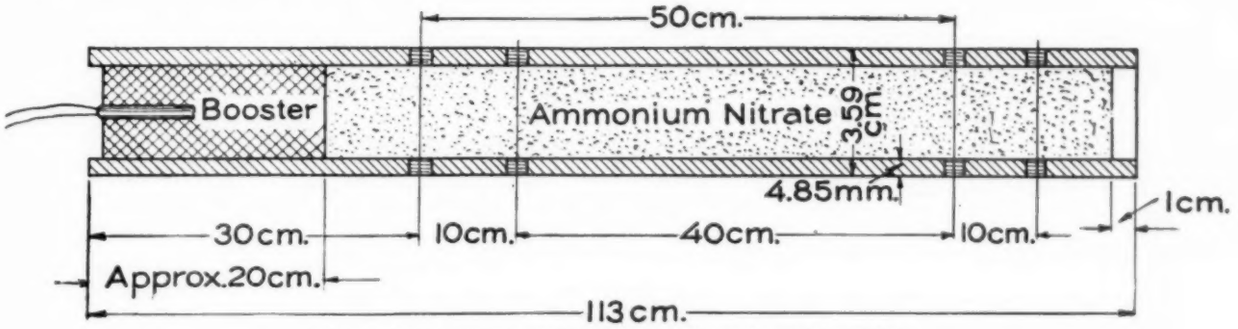


Fig. 1. Arrangement of Ammonium Nitrate in Shelby Tubing

Boosters.—The boosters used were: Tetryl, picric acid, TNT, 80/20 amatol, and 75/10 ammonium nitrate nitroglycerin dynamite.

Analyses are as follows:

	Tetryl	*Picric Acid*	*TNT*
Melting point, °C	128.9	.....	.....
Solidification point, °C	.....	121.06	80.2
Moisture, per cent	0.03	0.64	.....
Insoluble, per cent	0.24	0.03	.....
Acidity, per cent	0.0	.....	.....
Ash, per cent	0.08	0.018	.....
Nitrogen content, per cent	.....	18.17	18.14
Shaking density	0.99	0.93	0.96

*Report VI of the Committee on the Investigation of the Explosibility of Ammonium Compounds, National Research Council, conducted in co-operation with the Bureau of Mines. Published by permission of the Director, Bureau of Mines.

1. The Explosibility of Ammonium Nitrate, by Charles E. Munroe, *Chem. & Met. Eng.*, Vol. 26, 1922, pp. 535-542.
The Influence of Confinement on Explosibility of Ammonium Nitrate, by J. L. Sherrick, ARMY ORDNANCE, Vol. 4, 1924, pp. 329-333.
Fire Risks with Ammonium Nitrate, by J. L. Sherrick, ARMY ORDNANCE, Vol. 4, 1924, pp. 237-241.
The Influence of Density of Packing upon Explosibility of Ammonium Nitrate, by J. L. Sherrick, ARMY ORDNANCE, Vol. 4, 1924, pp. 395-400.
The Influence of Temperature on the Explosibility of Ammonium Nitrate, by G. W. Jones, ARMY ORDNANCE, Vol. 5, 1924, pp. 599-603.
2. Aufschlager, Rudolph, The Explosibility of Ammonium Nitrate. *Zeitschrift fur das Gesampte Schless und Sprengstoffwesen*, Vol. 15, No. 7, Nov.-Dec., 1923, p. 117.

Amatol.—There was considerable variation in different samples because the material was originally cast without stirring. The following figures were taken from eight different samples:

Constituent	*Variation, per cent*	*Average per cent.*
Moisture	0.04 to 0.06	0.05
Ammonium nitrate	71.30 to 83.19	79.95
TNT	16.76 to 28.04	20.00

As the cast was broken up, thoroughly mixed and screened, the average value represents the composition fairly accurately.

Analysis of the 75/10 ammonium nitrate-nitroglycerin dynamite is as follows:

Constituent	*Per cent*
Moisture	0.35
N. G. and N. P. G.	10.32
Ammonium nitrate	74.03
Sodium nitrate	1.87
Sodium chloride	6.99
Calcium carbonate	.51
Carbonaceous combustible matter	5.93
	100.00

Electric Detonators.—No. 8 electric detonators having a charge of approximately two grams were used throughout these tests. The charge consisted of 80 per cent mercury fulminate and 20 per cent potassium chlorate.

Determination of the Rate of Detonation at Ordinary Temperature

Shelby steel tubes 1-1/32 inch inside diameter and with wall 0.2 inch thick, were filled with ammonium nitrate at a density of approximately 0.71 to within 30 cm. of one end, as shown in Fig. 1. A thin rubber stopper was placed in the bottom of the tube and the holes in the sides were covered with tape, while the ammonium nitrate was added in 35-gram increments and shaken down by jarring on a large lead plate. The density was calculated from the length of charge, diameter of tube, and weight of ammonium nitrate added. A 100-gram booster of lightly tamped picric acid filled the remainder of the tube. The tape was then removed from over the holes in the sides of the tube and No. 36 B. & S. gage bare wires placed in the holes and sealed in with magnesium-oxide sodium-silicate cement. A No. 8 electric detonator was inserted in the booster and the wires were connected in a bomb-proof to a Mettegang recorder.[3] Two determinations of the rate of detonation were made on each tube. Results obtained of two shots measured over one-half meter are as follows:

Table 1.—**Results of Determination of Rate of Detonation at Ordinary Temperature**

Density of ammonium nitrate	First rate in m./sec.	Second rate in m./sec.	Average rate in m./sec.
0.70	1003	1100	1052
0.71	1005	1075	1040
		Average of 4 determinations	1046

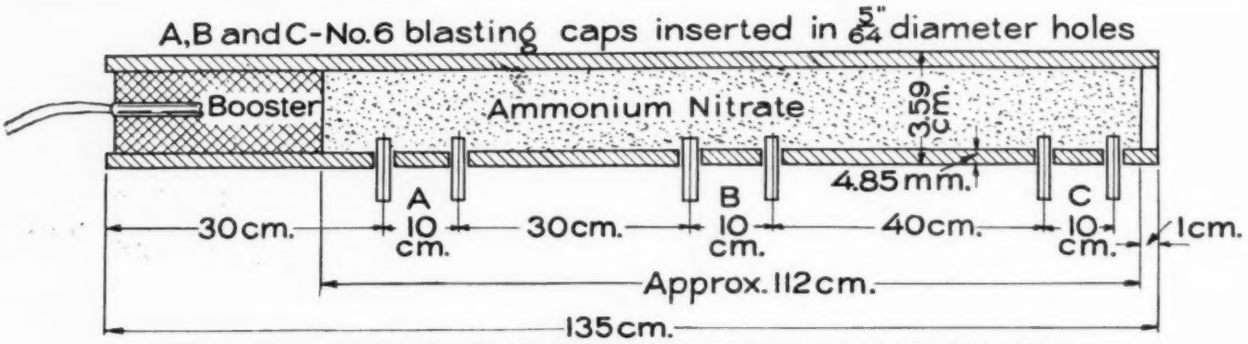


Fig. 2. Location of Blasting Caps for Determining Rate of Detonation by Dautriche Method

Complete detonation over 90 cm. having been obtained in the preceding tests with 100-gram boosters, further tests using 100-gram boosters were next carried out in Shelby tubes 135 cm. long, of the same diameter and thickness of wall, so prepared that the rate of detonation over various parts of the charge could be measured and at the same time the extent of propagation determined. The rate of detonation was determined by the Dautriche method[4] over 10 cm. of explosive in three places as shown in Fig. 2. Holes were drilled in the tube in which to fit No. 6 blasting caps. The caps were attached to Cordeau-Bickford detonating fuse with unions and inserted in the tube to a depth of ¼ inch. A 100-gram booster and No. 8 electric detonator were used to detonate the charge. Results obtained are as follows:

Table 2.—**Rate of Detonation Over Various Parts of Charge and Extent of Propagation.**

Booster 100 g.	Density	First rate	Second rate	Third rate	Length Detonated
Picric acid	0.68	1180	....	....	38.8*a*
Picric acid	.71	1165	....	....	33.8*a*
Picric acid	.71	1315	1455	....	113.5
Picric acid	.70	1300	1205	1175	112.6
Tetryl	.66	1290	....	....	40.2*a*
Tetryl	.68	1425	1290	....	112.3
TNT	.73	1300	1105	....	110.6
TNT	.70	1115	....	....	61.0*a*

*a*Incomplete detonation of NH_4NO_3.

3. Mettegang recorder, page 92, Bureau of Mines Bull. 15, 1911, Investigation of Explosives used in Coal Mines, by Clarence Hall, W. O. Snelling, S. P. Howell, G. A. Burrell, and C. E. Munroe.

4. Ref. Dautriche Method, page 26, Bureau of Mines Tech. Paper 186, 1918, Method for routine work in the explosives physical laboratory of the Bureau of Mines, by S. P. Howell and J. E. Tiffany.

In four of the eight tubes shot, detonation did not propagate the full length of the tube. The rate of detonation of the last 10 cm. of the charge was obtained in only one case where there was complete detonation.

Rate of Detonation Tests with Various Boosters at Elevated Temperatures

To determine the rate of detonation at elevated temperatures the charged tubes had to be heated in an oven. The oven used for this purpose would not allow a length of tube more than approximately 21 inches (53.5 cm.). It was desirable to shoot the tube with a minimum quantity of booster, as it allowed more space for ammonium nitrate and a correspondingly greater length over which to measure the rate of detonation. Accordingly, tests were made to determine the amount of booster necessary to detonate completely approximately a 40 cm. length of ammonium nitrate. These are given in Table 3.

Table 3.—**Average Lengths of Charge Detonated with Various Amounts of Picric Acid Used as a Booster**

Picric acid, grams	*Average length of charge detonated, cm.*
35	12
50	22
75	53.5
100	110

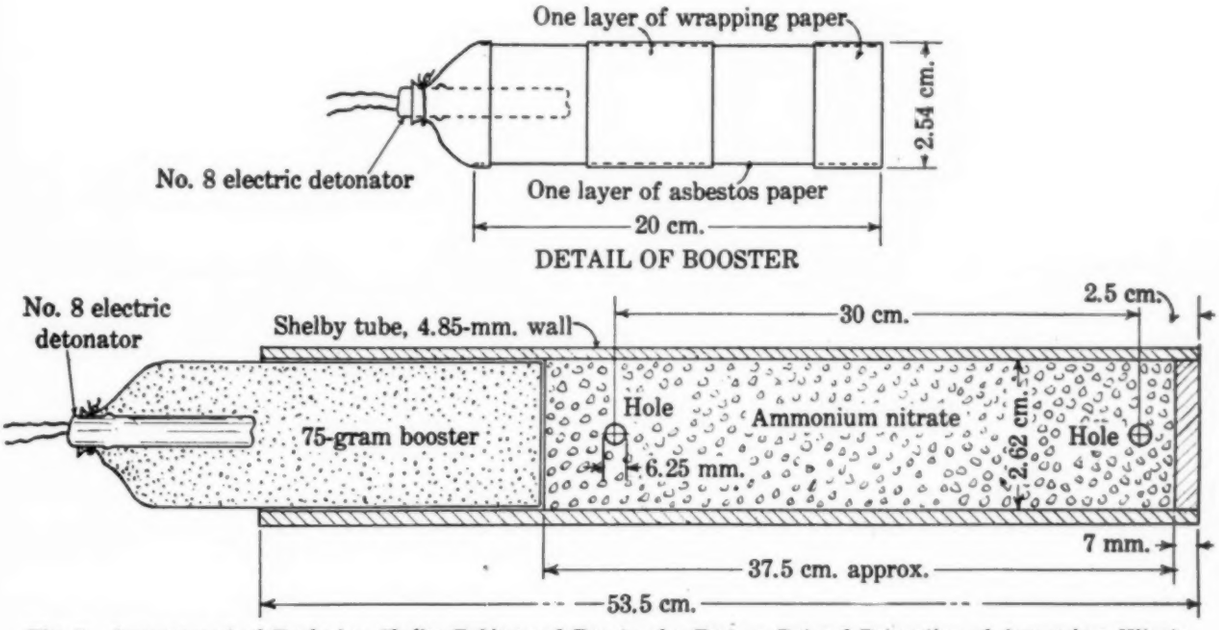


Fig. 3. Arrangement of Explosive, Shelby Tubing and Booster for Test on Rate of Detonation of Ammonium Nitrate

Test Procedure

Twenty-one inch (53 cm.) lengths of Shelby tubing were cut, drilled, and thoroughly cleaned of oil and chips. The tube was filled with approximately 37.5 cm. of NH_4NO_3 as described in previous tests and shown in Fig. 3. The tube was then placed in a Freas electric oven and heated at the desired temperature for at least four hours. The booster was made up separately in an asbestos wrapper cartridge consisting of one layer of asbestos paper held together with gummed paper and tied at the end with string, as shown in Fig. 3. The tube was removed from the oven and the wires sealed in. It was found that wires sealed in the tube and then heated were completely corroded through by the action of NH_4NO_3, hence the necessity of putting in wires after heating the tube. Connections were then made to the Mettegang recorder and the booster was inserted the last thing before leaving the bomb-proof. The charge was fired within five to six minutes after removing from the oven, and the temperature drop of the charge was from 4° to 5°C. which was allowed for in giving the temperature of the charge when shot. The asbestos wrapper effectually protected the booster from melting at the higher temperatures, as the time it was in contact with hot material was approximately one minute. Results are given in Table 4 and also plotted in Fig. 4.

Table 4.—**Rate of Detonation of Ammonium Nitrate at Temperature of 15 to 140°C., and Density of Loading of 0.68 to 0.73, with Picric Acid, Tetryl, TNT, 80/20 Amatol, and 75/10 Ammonium Nitrate-Nitroglycerin Dynamite Used as Boosters.**

75 g. booster	Temperature of firing, °C.	Rate of Detonation, m./sec.	Min.	Max.
Picric acid	15	1075	1007	1136
	40	1156	1152	1160
	80	1194	1147	1228
	100	1276	1237	1316
	120	1431	1314	1552
	140	1498	1444	1534
Tetryl	15	1141	1070	1191
	40	1190	1169	1222
	80	1226	1132	1301
	100	1380	1303	1425
	120	1490	1324	1610
	140	1560	1496	1687
TNT	15	Incomplete Detonation		
	40	1147	1139	1156
	80	1158	1140	1176
	100	1345	1255	1420
	120	1588	1562	1638
	140	1565	1498	1656
80/20 amatol	15	Incomplete Detonation	0–1078	1176
	40	1125	1107	1165
	80	1119	1036	1170
	120	1474	1419	1522
	140	1458	1454	1498
75/10 ammonium nitrate-nitroglycerin dynamite	15	Incomplete Detonation	0	
	40	Incomplete Detonation	0	
	80	1045	1002	1086
	120	1359	1266	1424
	140	1431	1349	1486

Rate of detonation as given is the average of 3 to 6 shots.

Conclusions

1. The results obtained during this investigation confirm the conclusions drawn by Sherrick and Jones in their studies of ammonium nitrate by other tests—namely, that detonation of ammonium nitrate is influenced by the nature of the booster, size of the booster, and the temperature of the ammonium nitrate.

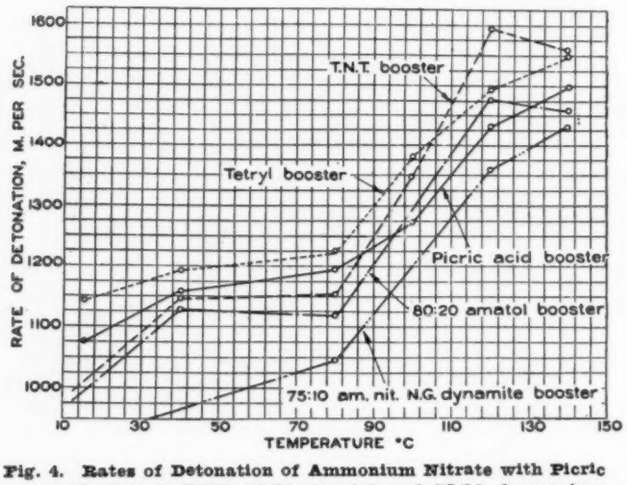


Fig. 4. Rates of Detonation of Ammonium Nitrate with Picric Acid, Tetryl, TNT, 80/20 Amatol and 75/10 Ammonium Nitrate-Nitroglycerin Dynamite used as Boosters

2. The rate of detonation of ammonium nitrate under the same conditions of confinement, diameter of charge, size and nature of booster, density of loading, and size of material, increases with increase of temperature.

3. The effect of temperature increase on rate of detonation is greatest between 80° and 120°C.

4. The size of booster used determines the extent to which a charge of ammonium nitrate can be detonated with certainty under definite set of conditions.

5. Under the conditions of these tests the relative efficiency of the booster is as follows: Tetryl, picric acid, TNT, 80/20 amatol, 75/10 ammonium nitrate dynamite.

6. The rate of detonation of the sample of ammonium nitrate used in these tests in Shelby seamless steel tube 1-1/32 inch inside diameter and 1½ inch outside diameter, at the normal shaking density 0.71, varies from 1000 meters per second at 15°C. to approximately 1700 meters per second at 140°C.

Acknowledgments

The author wishes to express his appreciation of the suggestions from Mr. J. E. Crawshaw, Explosives Engineer, and Mr. G. W. Jones, Associate Chemist, of the Explosives Section, Pittsburgh Experiment Station, U. S. Bureau of Mines.

Editorials

Major Somers Reassigned

MAJ. R. H. SOMERS, who has served as Secretary of the Army Ordnance Association and Editor of ARMY ORDNANCE during the past three years, relinquished his duties in these capacities July 1, 1925. By operation of law, Major Somers has been assigned a tour of military duty outside of Washington. He is succeeded by Maj. R. L. Maxwell, Ord. Dept., as secretary and editor.

Due in great degree to the untiring efforts of Major Somers, the Army Ordnance Association during his tenure of office carried on its activities with an ever broadening effect. He maintained the high standards which have marked the Association since its foundation and, under his direction, our membership has grown steadily. His work in the interest of adequate national preparedness has been of the highest caliber.

I personally feel, and am sure all the members of the Association concur, that to Major Somers is due our hearty thanks for his constant and tireless work in the interests of the Association, and in my own name and in behalf of the Association I take this opportunity to thank him and to extend every good wish for his future.

Benedict Crowell

BENEDICT CROWELL, *President.*

Ordnance Foreign Service

THOSE of us whose idea of industrial preparedness is confined to the mere development and manufacture of munitions for war may very often lose sight of the tremendous problem which the Ordnance Department has to meet in the supply and maintenance of armament for our peace-time Army. This task is one of the most exacting of the many duties which the Ordnance Department is called upon to perform not alone in the supply and maintenance of material in the Continental United States but also in the foreign and insular possessions.

In this issue of ARMY ORDNANCE we have attempted to give our readers some idea of the importance of ordnance supply in the foreign service. We are able to present well written articles by Ordnance personnel located outside the continental limits of the United States who describe the activities of the Ordnance Depots in Panama, Hawaii and the Philippines. These articles, descriptive as they are of the Ordnance establishments at these places, also give one an idea of the maintenance and supply services being performed by the Ordnance Department in the insular possessions.

Many believe that this function of the Ordnance Department is its most important peace-time work. Certain it is that its far-spread area makes it one of the most difficult of fulfilment of all the various activities of the Department.

Wherever you find the American flag you find American Ordnance in some form, the two travel together, work together and are important members of the All-American Team.

We only have to consult our subscription list to learn that ARMY ORDNANCE counts among its readers many nationals of foreign countries and this evidence of interest in American Ordnance is a source of pride.

Defense Day, 1925

AMONG the many published opinions in and out of the Army as to the success of Defense Day, 1925, that of Maj. Gen. John L. Hines, Chief of Staff of the Army, is probably the most significant.

Expressing the pleasure of War Department officials upon the results of this second annual defense test, General Hines stated his willingness to go before Congress and ask for legislation that would authorize the test being made an annual affair. Approval by Congress will be new evidence of faith in the National Defense Act of 1921.

The second Defense Day test—that of 1925—eclipsed the first—that of 1924—in many respects. There was a more general spirit of co-operation among practically the entire population of the country as evidenced by the state and municipal officials who assisted the federal authorities in devoting Independence Day to a two-fold purpose: the commemoration of the signing of our own Magna Charta and an examination of our state of preparedness. There was an atmosphere of personal responsibility about those who participated. Moreover, the slight opposition which was evident in certain quarters during 1924 had practically disappeared in 1925, so that it may be said with reasonable assurance that our people generally are cognizant of the extreme importance of national defense and are willing to devote one day of the year to a consideration of our real condition in that respect.

Defense Day has proved its value by the two annual tests held thus far. It is to be hoped that whatever action is necessary will be taken to secure legislation by the Congress for an annual Defense Day for the future.

Those who helped to make Defense Day, 1925, the success it was can well take to themselves personally the congratulations of General Hines which he sent in his message to the Corps Area Commanders:

"The War Department extends to you and through you to the people of your corps area its congratulations upon the splendid success attending the observance of the Defense Day of July 4.

"Without your assistance and that of the citizens of your

corps area who have given their time and services to the cause of preparedness and security of our country, the defense test could not have been the great patriotic success that it was."

Ordnance Reserve Training Camps

PRESENT indications are that the officers' training camps to be held for the Ordnance Reserve Officers at the Aberdeen Proving Ground and Rock Island Arsenal during August, 1925, will be among the most successful activities of the Ordnance Reserve to date. Applications for training have been received in encouraging number by the officials of the Ordnance Department, and the training camps season of 1925 is expected to outrank in numbers those of previous years.

This is merely another indication of the widespread and growing interest upon the part of all Reserve Officers and of Ordnance Reserves in particular, of the seriousness in which reserve commissions are held. We know of no better indication of the general co-operation so necessary for the success of the Reserve Corps than the spirit in which the training camp program is being entered into. It is new evidence of the wisdom of the provision which established the Reserve.

The past season together with the summer training camps has evidenced an unusual interest in ordance reserve activities. Those in the Ordnance Department who are charged with the responsibility of ordnance reserve training are to be congratulated, while the Reserve Officers themselves who are assisting in the work are also entitled to a measure of thanks.

Who's Who in This Issue

MAJ. ROBERT SEARS, Ord. Dept., an expert rifleman, introduces Maj. Gen. Robert H. Allen, recently appointed Chief of Infantry, and tells of some of his accomplishments both as a rifle shot and as coach of several of the American teams which participated in International Rifle Matches. From Major Sears' observations it is evident that the United States Infantry is indeed fortunate in having for its chief one who understands most thoroughly the use of the rifle in which every good infantryman must be proficient.

Maj. O. J. Gatchell has occupied many important posts in the Ordnance Department during and since the World War. A former executive assistant to the Chief of Ordnance and for several years an assistant in the Department of Ordnance and Gunnery at West Point, Major Gatchell now commands the Panama Ordnance Depot and is Ordnance Officer of the Panama Department.

Maj. W. L. Clay, author of "Ordnance Activities in Hawaii," is Ordnance Officer of the Hawaiian Department and is therefore well qualified to given an authentic description of the valuable work of Army Ordnance in that important outpost of the Pacific. Major Clay has filled many high positions in the Coast Artillery and in the Ordnance Department.

Maj. James Kirk describes the activities of the Department at the largest post in Hawaii in his article, "Ordnance at Schofield Barracks." Major Kirk has been on duty in Hawaii for several years and describes in interesting detail the ordnance establishment at his post and the work it is called upon to perform.

Col. Bruce Cornwall, Chief of the San Francisco Ordnance District, presents a resume of the activities of that district since its formation. Colonel Cornwall served with distinction with the Ordnance Department during the World War and is one of the most active ordnance enthusiasts on the Pacific Coast today. Under his direction the San Francisco Ordnance District has accomplished a great deal toward adequate industrial preparedness on the West Coast.

Prof. F. W. Power, S. J., is professor of chemistry at Fordham University. In his article, "A Calculated Relation Between the Ballistics of the 75-mm. Gun and the Mean Web of the Powder," he publishes some important research work which he performed immediately after the World War. His investigations and calculations will be of interest to our many readers who follow the remarkable strides being made in the improvement of American propellants.

Supplementing what Major Gatchell has written, Capt. R. L. Bowlin describes in detail small arms maintenance in Panama. Captain Bowlin is assistant to Major Gatchell and in charge of the maintenance of small arms and small arms ammunition in the Canal Zone.

"Military and Commercial Powder and Explosives" is contributed to this issue by Col. William C. Spruance, Vice-President of E. I. du Pont de Nemours & Co. A charter member of the Army Ordnance Association and one of its ardent supporters, Colonel Spruance is preeminently equipped to write on this important topic. During the World War he was in charge of powder and explosives production in the Ordnance Department and his record in this important assignment is well known.

Mr. H. F. Olmsted, a member of the engineering staff of the Packard Motor Car Company, describes the new Packard tank engine developed by that organization in co-operation with the Rock Island Arsenal and the Ordnance Department. A radical departure in design of automotive equipment, this engine bids fair to add greatly to the effectiveness of the American tank.

Maj. George Schuster, Ord. Res., serves as automotive engineer on the staff of the Artillery Division, Manufacturing Service, Office of the Chief of Ordnance. Having been associated with the design and development of the cross-country car, the evolution of which he describes in his article, "Development of the Cross-Country Car," his article is based on a knowledge of the entire project.

"Red and Yellow Ammonium Picrate" is the work of Dr. G. C. Hale, Chief Chemist at Picatinny Arsenal, whose valuable contributions on chemical topics in these pages already make him well known to our readers. Dr. Hale did important chemical research work with the American Forces in Germany after the World War and his current investigations at Picatinny include many of the most important problems upon which the Ordnance Department is engaged.

Mr. D. B. Gawthrop is an explosives engineer on the staff of the Pittsburgh Experiment Station, Bureau of Mines. In his article, "The Influence of Temperature on the Detonation of Ammonium Nitrate," he adds considerable data to what has already been published in ARMY ORDNANCE on the explosive properties of this substance.

Reserve Corps Notes

Items of Interest to Members of the Ordnance Department Reserve

Edited by Major John A. Brooks, Jr., Military Personnel Section, Office of the Chief of Ordnance

Ordnance Reserve Officers' Summer Training Camps

AS ANNOUNCED in the May-June issue of ARMY ORDNANCE, summer training camps for members of the Branch Assignment group of the Ordnance Officers' Reserve will be held at the Aberdeen Proving Ground from August 2nd to 16th, and at Rock Island Arsenal from August 16th to 30th. Orders have been issued to those who are to attend the camps, and it is planned to feature articles descriptive of both camps in the next issue of ARMY ORDNANCE.

R. O. T. C. Prizes at Yale

WORD has been received from the Secretary of Yale University announcing the winners of prizes for the best essays submitted on the topic, "The Training and Development of Ordnance Officers for the United States Army, Especially from the Viewpoint of the Ordnance Reserve Corps." The winners are as follows: First prize, James M. Lynch; second prize, H. E. Smith; third prize, W. P. Sargent, Jr.; fourth prize, A. Gordon Moody; honorable mention—J. G. Moffett, J. H. Aiken, Edward J. Holahan, Wallace W. Hoge, and Howard A. Light.

The competition was open to all R. O. T. C. students at Yale University. The prizes were the gift of an anonymous donor. The prize winning essay, and possibly that which was awarded second place, will be published in an early issue of this journal.

Spring Training

TRAINING courses for Ordnance Reserve Officers were conducted at the following establishments during the periods indicated. The names of the officers who attended are listed below.

BALTIMORE DISTRICT ORDNANCE OFFICE

Capt. Paul Anderson, Ord. Res., May 10 to May 24, 1925.
Maj. Linn W. Searles, Ord. Res., May 31 to June 14, 1925.

ROCK ISLAND ARSENAL

June 14 to June 28, 1925.

Capt. Joseph M. Michaelson, Ord. Res.;
1st Lieut. Justus Rising, Ord. Res.

SPRINGFIELD ARMORY

May 31 to June 14, 1925.

Major John H. Barrett, Ord. Res.;
Major Jules Dierekx, Ord. Res.;
Major William C. Swift, Ord. Res.;
Major Bernard Whittaker, Ord. Res.;
2nd Lt. Charles E. Herrstrom, Ord. Res.;
2nd Lt. Matthew F. Mountain, Ord. Res.;
2nd Lt. George R. Tuttle, Ord. Res.

WASHINGTON, D. C.

Major Stephen K. Plume, Ord. Res.; May 3 to May 17, 1925.
Capt. Bolivar T. Reamy, Ord. Res.; June 14 to June 28, 1925.
Capt. Edward E. Tanguy, Ord. Res.; May 17 to May 31, 1925.

WATERVLIET ARSENAL

May 31 to June 14, 1925.

Major James S. Smyser, Ord. Res.;
Capt. Henry B. Reardon, Jr., Ord. Res.;
1st Lieut. Roland W. Sellew, Ord. Res.;
2nd Lieut. Donald A. Rogers, Ord. Res.

CHICAGO DISTRICT ORDNANCE OFFICE

1st Lieut. Levi C. Eddy, Ord. Res.; May 31 to June 14, 1925.
1st Lieut. William A. Fay, Ord. Res.; May 17 to May 31, 1925.

ABERDEEN PROVING GROUND

Lt. Col. Peter Field, Ord. Res.; June 7 to June 21, 1925.
Lt. Col. James Guthrie, Ord. Res.; June 7 to June 21, 1925.
Maj. Roger S. Hoar, Ord. Res.; June 14 to June 28, 1925.
Maj. Kenneth L. Holmes, Ord. Res.; June 16 to June 30, 1925.
Maj. Gerald E. Tenney, Ord. Res.; June 7 to June 14, 1925.
1st Lieut. Benjamin D. Roddey, Ord. Res.; June 7 to June 21, 1925.
1st Lieut. Charles L. Yost, Ord. Res.; June 7 to June 21, 1925.

FRANKFORD ARSENAL

May 31 to June 14, 1925.

Maj. George A. Post, Ord. Res.;
Capt. George J. Schladt, Ord. Res.;
Capt. Arthur F. Van Buskirk, Ord. Res.;
1st Lieut. Herbert K. Cummings, Ord. Res.;
2nd Lieut. Whitney B. Hobbs, Ord. Res.;
2nd Lieut. Albert M. Young.

WATERTOWN ARSENAL

Lt. Col. Watson M. Myers, Ord. Res.; June 14 to June 28, 1925.
Maj. Albert W. Draves, Ord. Res.; May 31 to June 14, 1925.
Maj. Howard P. Elwell, Ord. Res.; June 14 to June 28, 1925.
Maj. Hiram B. Guise, Ord. Res.; June 14 to June 28, 1925.
Maj. Edmund T. D. Myers, Ord. Res.; June 14 to June 28, 1925.
Maj. Emil F. Norelius, Ord. Res.; June 14 to June 28, 1925.
Maj. Fay B. Williams, Ord. Res.; May 31 to June 14, 1925.
Capt. Roswell J. Clapp, Ord. Res.; May 31 to June 14, 1925.
Capt. Fred R. Zimmerman, Ord. Res.; June 14 to June 28, 1925.
Capt. Samuel M. Regar, Ord. Res.; June 14 to June 28, 1925.
2nd Lt. William S. Gould, Jr. Ord. Res.; May 31 to June 14, 1925.
2nd Lt. William B. Johns, Jr. Ord. Res.; June 14 to June 28, 1925.
2nd Lt. John Slezak, Ord. Res.; May 31 to June 14, 1925.
2nd Lt. Harry P. Croft, Ord. Res.; May 31 to June 14, 1925.
2nd Lt. Gilbert I. Ross, Ord. Res.; May 31 to June 14, 1925.
2nd Lt. George H. Pfefferle, Ord. Res.; June 14 to June 28, 1925.
2nd Lt. John K. Laycock, Jr., Ord. Res.; June 14 to June 28, 1925.
2nd Lt. Patrick C. O'Shee, Ord. Res.; June 14 to June 28, 1925.
2nd Lt. Frank H. Smith, Jr. Ord. Res.; June 14 to June 28, 1925.
2nd Lt. Albert C. Durham, Ord. Res.; June 14 to June 28, 1925.
2nd Lt. Benjamin M. Shaub, Ord. Res.; June 14 to June 28, 1925.
2nd Lt. Warren G. Coryell, Ord. Res.; June 14 to June 28, 1925.
2nd Lt. Norman E. Dietz, Ord. Res.; June 14 to June 28, 1925.
2nd Lt. Owen V. Keller, Ord. Res.; June 14 to June 28, 1925.
2nd Lt. Leon H. Jagrowski, Ord. Res.; June 14 to June 28, 1925.
2nd Lt. Harry S. Nelson, Ord. Res.; June 17 to June 30, 1925.
2nd Lt. Joseph G. Moffett, Ord. Res.; June 17 to June 30, 1925.
2nd Lt. Edward F. Dirks, Ord. Res.; June 17 to June 30, 1925.
2nd Lt. Myron E. Doucette, Ord. Res.; June 17 to June 30, 1925.
2nd Lt. George Oetinger, Ord. Res.; June 17 to June 30, 1925.
2nd Lt. James H. Howard, Ord. Res.; June 17 to June 30, 1925.
2nd Lt. John M. Campbell, Ord. Res.; June 17 to June 30, 1925.
2nd Lt. Edward W. Eager, Jr., Ord. Res.; June 17 to June 30, 1925.

9TH CORPS AREA

May 10 to May 24, 1925.

Lt. Col. Fred L. M. Masury, Ord. Res.;
Maj. James Spiers, Ord. Res.;
Maj. Walter H. Adams, Ord. Res.;
Capt. Arthur B. Domonoske, Ord. Res.;
Capt. William M. Moody, Ord. Res.;
1st Lieut. Howard P. Witten, Ord. Res.;
1st Lieut. George E. Frahm, Ord. Res.;
2nd Lieut. Lawrence A. Anderson, Ord. Res.

SAN ANTONIO ARSENAL

June 14 to June 28, 1925.

Capt. Walter Graham, Ord. Res.;
1st Lieut. Frank E. Sullivan, Ord. Res.

CURTIS BAY ORDNANCE RESERVE DEPOT

May 20 to May 26, 1925.

1st Lieut. Edwin L. Davis, Ord. Res.

CAMP KNOX, KY.

June 7 to June 21, 1925.

Major Harold McGeorge, Ord. Res.

BENICIA ARSENAL

June 14 to June 28, 1925.

Capt. William E. Robinson, Ord. Res.;
2nd Lieut. Frederick B. McNeil, Ord. Res.

NEW YORK DISTRICT ORDNANCE OFFICE

June 5 to June 19, 1925.

1st Lieut. Norman D. Douglass, Ord. Res.

CHARLESTON ORDNANCE RESERVE DEPOT

June 14 to June 28, 1925.

1st Lieut. Louna W. Holland, Ord. Res.

PICATINNY ARSENAL

June 14 to June 28, 1925.

Maj. Henry B. Faber, Ord. Res.

A total of 199 officers of the Branch Assignment Group were trained during the fiscal year 1925.

Regulations for the Officers Reserve Corps

THERE are three sections of Army Regulations which are of special interest to members of the Ordnance Department Reserve. They are A. R. 140-5, 140-21 and 140-36. The first gives general information regarding an officer's service in the Reserve; the second gives information regarding the functions of examining boards; and the third gives in detial the qualifications required for appointment and promotion in the Ordnance Department Reserve.

A sufficient number of copies of each of these regulations is being printed for each officer of the Ordnance Department Reserve. It is expected that all will have been received from the printer by August 1st, and distribution will be made through the various Corps Area Commanders.

If you do not receive your copies by the middle of September it is suggested that you send a request to your Corps Area Commander.

Recently Commissioned Ordnance Reserve Officers

THE following have accepted reserve commissions since last issue of ARMY ORDNANCE:

Col. George R. Norton, Ord. Res.,
123 Pomeroy Ave., Pittsfield, Mass.

Maj. Henry K. Benson, Ord. Res.,
8602 12th Ave., N. E., Seattle, Wash.

Maj. Leroy E. Briggs, Ord. Res.,
169 Princeton Ave., Providence, R. I.

Maj. Victor F. Emerson, Ord. Res.,
6381 Overbrook Ave., Philadelphia, Pa.

Maj. Henry G. Hawes, Jr., Ord. Res.,
147 Lee Ave. Ext., Scarsdale, N. Y.

Maj. George Henderson, Ord. Res.,
519 Washington St., Cumberland, Md.

Maj. Henry Huss, Ord. Res.,
Prospect & Crary Aves., Mount Vernon, N. Y.

Maj. Francis T. Letchfield, Ord. Res.,
1001 Merchants Exchange Bldg., San Francisco, Cal.

Maj. Frederick A. Lorenz, Ord. Res.,
1724 E. 56th St., Chicago, Ill.

Maj. Francis W. Parker, Ord. Res.,
140 S. Dearbon St., Chicago, Ill.

Maj. Garnet M. Sixsmith, Ord. Res.,
505 So. Negley Ave., Pittsburgh, Pa.

Capt. Miles C. Bland, Ord. Res.,
228 North Delaware Ave., Philadelphia, Pa.

Capt. James R. Cardwell, Ord. Res.,
Fort Barrancas, Fla.

Capt. John B. Grier, Ord. Res.,
Rockland, Del.

Capt. Frank N. Sarber, Ord. Res.,
1601 Lincoln Way, McKeesport, Pa.

Capt. Roland F. Wilson, Ord. Res.,
802 Patterson Bldg., Denver, Colo.

1st Lieut. George R. Hilby, Ord. Res.,
Executive Mansion, Sacramento, Cal.

1st Lieut. Herbert H. Mitchell, Ord. Res.,
1105 K St., N. W., Washington, D. C.

1st Lieut. George B. Roth, Ord. Res.,
65 13th St., Troy, N. Y.

1st Lieut. Samuel P. Savage, Ord. Res.,
care International G. E., Schenectady, N. Y.

1st Lieut. Carlyle H. Strand, Ord. Res.,
2138 California St., N. W., Washington, D. C.

1st Lieut. John P. Vollrath, Jr., Ord. Res.,
528 Hudson St., Hoboken, N. J.

2nd Lieut. Angelo J. Alama, Ord. Res.,
32 Pomeroy St., Cortland, N. Y.

2nd Lieut. Lee C. Bennett, Ord. Res.,
136 Laurel Ave., Binghamton, N. Y.

2nd Lieut. William Bisch, Ord. Res.,
195 West End Ave., Newark, N. J.

2nd Lieut. Edward L. Booth, Ord. Res.,
1231 Martine Ave., Plainfield, N. J.

2nd Lieut. Alexander M. Brown, Ord. Res.,
33 Lexington Ave., Dayton, O.

2nd Lieut. Howard W. Burden, Ord. Res.,
48 Cortland St., Homer, N. Y.

2nd Lieut. John M. Campbell, Ord. Res.,
14 Kensington Rd., Arlington, Mass.

2nd Lieut. Harold M. Catlin, Ord. Res.,
602 N. Main St., Athens, Pa.

2nd Lieut. Lloyd Colston, Ord. Res.,
41 Roosevelt Ave., Binghamton, N. Y.

2nd Lieut. Warren G. Coryell, Ord. Res.,
1719 Ohio Ave., Youngstown, O.

2nd Lieut. Raymond G. Curtin, Ord. Res.,
1850 East 14th St., Brooklyn, N. Y.

2nd Lieut. Raymond A. Dewey, Ord. Res.,
264 Western Ave., Albany, N. Y.

2nd Lieut. Norman E. Dietz, Ord. Res.,
1505 Sixth St., Muskegon, Mich.

2nd Lieut. Edward F. Dirks, Ord. Res.,
11 Harbor St., Danvers, Mass.

2nd Lieut. Evander S. Dixon, Ord. Res.,
1811 Reid St., Los Angeles, Cal.

2nd Lieut. Myron E. Doucette, Ord. Res.,
10 Woodland Way, Haverhill, Mass.

2nd Lieut. George M. Droge, Ord. Res.,
3 Summit Ave., River Edge, N. J.

2nd Lieut. Ralph L. Dunckel, Ord. Res.,
Fort Plain, N. Y.

2nd Lieut. Albert C. Durham, Ord. Res.,
Acworth, Ga.

2nd Lieut. Edward W. Eager, Jr., Ord. Res.,
Canterbury St., Hingham, Mass.

2nd Lieut. Henry A. Gerken, Ord. Res.,
48 Sherman St., Brooklyn, N. Y.

2nd Lieut. Vernon W. Griffith, Ord. Res.,
78 Hamilton St., Pontiac, Mich.

2nd Lieut. Peter G. Hanigan, Ord. Res.,
132 34th St., Woodcliff, N. J.

2nd Lieut. James H. Howard, Ord. Res.,
54 Cottage St., Watertown, Mass.

2nd Lieut. Leon H. Jagrowski, Ord. Res.,
2592 Lakeview Ave., Detroit, Mich.

2nd Lieut. Joseph O. Jeffrey, Ord. Res.,
113 West 94th St., New York, N. Y.

2nd Lieut. James T. Johnson, Jr., Ord. Res.,
Montevallo, Ala.

2nd Lieut. Owen V. Keller, Ord. Res.,
2052 Dalzelle St., Detroit, Mich.

2nd Lieut. John K. Laycock, Jr., Ord. Res.,
P. O. Box 166, Baton Rouge, La.

2nd Lieut. Raymond A. Martin, Ord. Res.,
296 Boulevard, Passaic, N. J.

2nd Lieut. Robert P. Mason, Ord. Res.,
10 Foster St., Attleboro, N. Y.

2nd Lieut. Charles McCauley, Ord. Res.,
32 Wool St., San Francisco, Cal.

2nd Lieut. Joseph G. Moffett, Ord. Res.,
185 Sylvester St., Springfield, Mass.

2nd Lieut. Thomas G. Murdock, Ord. Res.,
care Sloss-Sheffield Steel & Iron Co., Attala, Ala.

2nd Lieut. Alfred W. Nagel, Ord. Res.,
2643 Pike Ave., Ensley, Ala.

2nd Lieut. Harry S. Nelson, Ord. Res.,
Mount Carmel, Conn.

2nd Lieut. George Oetinger, Jr., Ord. Res., 200 S. Huntington Ave., Boston, Mass.

2nd Lieut. Patrick C. O'Shee, Ord. Res., 819 Washington St., Alexandria, La.

2nd Lieut. George E. Pierson, Ord. Res., 29 E. Broad St., Hopewell, N. J.

2nd Lieut. Glendale M. Price, Ord. Res., Dundee, N. Y.

2nd Lieut. John H. Sendele, Ord. Res., 247 Nuber Ave., Mount Vernon, N. Y.

2nd Lieut. Benjamin M. Shaub, Ord. Res., York Co., New Freedom, Pa.

2nd Lieut. Frank H. Smith, Jr., Ord. Res., 324 Remington Ave., Thomasville, Ga.

2nd Lieut. Clarence E. Vendley, Ord. Res., 966 So. Serrano Ave., Los Angeles, Cal.

2nd Lieut. Clinton M. Vernon, Ord. Res., 38 Prospect St., Middletown, N. Y.

2nd Lieut. Earl M. Ward, Ord. Res., 835 3rd Ave., E., Cedar Rapids, Iowa.

2nd Lieut. Teddie W. White, Ord. Res., Little Rock Air Intermediate Depot, Little Rock, Ark.

Recently Assigned Ordnance Reserve Officers

THE following reserve officers have recently been assigned as indicated after their names:

Col. George R. Norton, Ord. Res., Field Service, General Supply Division, Washington, D. C.

Maj. Henry K. Benson, Ord. Res., Manufacturing Service, San Francisco District Ord. Office, San Francisco, Cal.

Maj. Leroy E. Briggs, Ord. Res., Manufacturing Service, Bridgeport District Ord. Office, Bridgeport, Conn.

Maj. Carlos de Zafra, Ord. Res., Manufacturing Service, New York District Ord. Office, New York, N. Y.

Maj. Perry W. Goodman, Ord. Res., Field Service, New York District Ord. Office, New York, N. Y.

Maj. Henry G. Hawes, Jr., Ord. Res., Manufacturing Service, New York District Ord. Office, New York, N. Y.

Maj. George Henderson, Ord. Res., Territorial Assignment Group.

Maj. Francis T. Letchfield, Ord. Res., Manufacturing Service, San Francisco District Ord. Office, San Francisco, Cal.

Maj. Frederick A. Lorenz, Ord. Res., Manufacturing Service, Chicago District Ord. Office, Chicago, Ill.

Maj. Emil F. Norelius, Ord. Res., Manufacturing Service, Rock Island Arsenal, Rock Island, Ill.

Maj. Francis W. Parker, Ord. Res., Manufacturing Service, Small Arms Div., Washington, D. C.

Maj. Garnet M. Sixsmith, Ord. Res., Manufacturing Service, Pittsburgh District Ord. Office, Pittsburgh, Pa.

Capt. James R. Cardwell, Ord. Res., Territorial Assignment Group.

Capt. John B. Grier, Ord. Res., Territorial Assignment Group.

Capt. Frank N. Sarber, Ord. Res., Manufacturing Service, Pittsburgh District Ord. Office, Pittsburgh, Pa.

Capt. Ralph W. Smith, Ord. Res., Manufacturing Service, San Francisco District Ord. Office, San Francisco, Cal.

Capt. Francis J. Thomas, Ord. Res., Manufacturing Service, Bridgeport District Ord. Office, Bridgeport, Conn.

Capt. Roland F. Wilson, Ord. Res., Manufacturing Service, St. Louis District Ord. Office, St. Louis, Mo.

1st Lieut. John S. Carter, Ord. Res., Manufacturing Service, Boston District Ord. Office, Boston, Mass.

1st Lieut. David L. Fiske, Ord. Res., Technical Staff, Aberdeen Proving Ground, Aberdeen, Md.

1st Lieut. Timothy N. Holden, Jr., Ord. Res., Manufacturing Service, New York District Ord. Office, New York, N. Y.

1st Lieut. Richard Kent, Ord. Res., Manufacturing Service, Cincinnati Dist. Ord. Office, Cincinnati, O.

1st Lieut. Herbert H. Mitchell, Ord. Res., Manufacturing Service, Artillery Division, Washington, D. C.

1st Lieut. Kenneth C. Monroe, Ord. Res., Manufacturing Service, Bridgeport District Ord. Office, Bridgeport, Conn.

1st Lieut. George A. Moshchansky, Ord. Res., Manufacturing Service, Chicago District Ord. Office, Chicago, Ill.

1st Lieut. Samuel P. Savage, Ord. Res., Territorial Assignment Group.

1st Lieut. Carlyle H. Strand, Ord. Res., Manufacturing Service, Artillery Division, Washington, D. C.

1st Lieut. John P. Vollrath, Jr., Ord. Res., Manufacturing Service, New York Dist. Ord. Office, New York, N. Y.

2nd Lieut. Alexander M. Brown, Ord. Res., Territorial Assignment Group.

2nd Lieut. Huntley M. Campbell, Ord. Res., Manufacturing Service, Cleveland District Ord. Office, Cleveland, O.

2nd Lieut. John M. Campbell, Ord. Res., Manufacturing Service, Picatinny Arsenal, Dover, N. J.

2nd Lieut. Charles R. Currier, Ord. Res., Manufacturing Service, San Francisco District Ord. Office, San Francisco, Cal.

2nd Lieut. Edward F. Dirks, Ord. Res., Manufacturing Service, Picatinny Arsenal, Dover, N. J.

2nd Lieut. Evander S. Dixon, Ord. Res., Territorial Assignment Group.

2nd Lieut. Vernon W. Griffith, Ord. Res., Territorial Assignment Group.

2nd Lieut. Arthur B. Hansen, Ord. Res., Administration Division, Auxiliary Section, Washington, D. C.

2nd Lieut. Charles H. McCann, Ord. Res., Manufacturing Service, Bridgeport District Ord. Office, Bridgeport, Conn.

2nd Lieut. Charles McCauley, Ord. Res., Territorial Assignment Group.

2nd Lieut. Sidney Quinby, Ord. Res., Manufacturing Service, Buffalo District Ord. Office, Buffalo, N. Y.

2nd Lieut. John H. Sendele, Ord. Res., Territorial Assignment Group.

2nd Lieut. Clarence E. Vendley, Ord. Res., Territorial Assignment Group.

2nd Lieut. Earl M. Ward, Ord. Res., Territorial Assignment Group.

2nd Lieut. Teddie W. White, Ord. Res., Territorial Assignment Group.

2nd Lieut. Walter E. Wickstrom, Ord. Res., Manufacturing Service, Bridgeport District Ord. Office, Bridgeport, Conn.

Professional Notes

PITTSBURGH ORDNANCE DISTRICT

DURING the past year the industrial mobilization plans of the Pittsburgh Ordnance District have made definite progress. A "skeleton" organization has been built up consisting of 38 Ordnance Reserve Officers with definite assignments for duty in the event of an emergency, in addition to a number of especially qualified civilians who have agreed to fill "key-positions" in the organization of the District Office in the event that their services are required. The commissioned personnel requirements which have not yet been filled consist largely of Ordnance Reserve Officers to be commissioned in the grades of first and second Lieutenants. The latter are required to supervise inspection and production at the various plants in the District which will produce Ordnance matériel in time of emergency.

Allocation to industrial plants of Ordnance War Orders for artillery ammunition has now been practically completed and tentative plans now being developed will provide for definite sources of supply of high explosives and propellant charges. The District War Plan also provides for loading plants and proving grounds. In selecting sites for the latter, aerial photographs, made by the Army Air Service, have been of valuable assistance in preparing maps of the areas under consideration.

Following the allocation of Ordnance War Orders to this District by the Chief of Ordnance, an elaborate plan has been worked out which involves the procurement of the various component items required to make up the complete round of artillery ammunition ready for issue to Field Service. This plan involves a number of the largest industrial concerns in the country, who have given much valuable advice and assistance in the preparation of "paper plans" for their individual plants. Detailed War Plans are being developed which will include necessary information as follows: (a) Machine tool requirements and preferred sources of supply; (b) Route sheets for articles to be produced; (c) Raw material requirements; (d) Transportation, power, and labor requirements.

In the development of these Factory War Plans, the entire expense is being borne by the individual manufacturers who have offered the services of their several engineering staffs to work out plans in sufficient detail so that they might be put into operation with the least possible delay.

The total estimated cost of Ordnance War Orders tentatively allocated to manufacturers in this District, for artillery ammunition alone, is approximately two hundred and fifty-five million dollars.

J. A. ROOT,
Captain, Ord. Dept., U. S. A.
Executive Assistant, Pittsburgh Ordnance District.

PICATINNY ARSENAL

Some of the Explosive Properties of Beta and Gamma TNT

EVERY explosive in its pure state has a fairly characteristic sensitiveness to various influences which cause its detonation. It also has a fairly characteristic brisance. It has been long recognized that these properties are influenced by a number of factors such as temperature, physical conditions and purity. It is, therefore, not at all difficult to understand why there should be some variation in the explosive properties of different samples of the same explosive as manufactured. This variation, within certain limits, is indeed to be expected, but these limits have been fairly well established for the commonly used explosives and manufacturing practice has been standardized to such a degree that the variation is not great.

Grade I TNT being a refined and fairly pure product has very uniform explosive properties, but slight variations from lot to lot are perceptible even with it. This slight variation it was thought might be due to the presence of variable amounts of the beta and gamma isomers present, which might have properties somewhat different from alpha TNT and might impart them in a slight degree, to the mass. Although the question of the explosive properties of the beta and gamma isomers as compared with alpha is chiefly one of academic interest, it was nevertheless thought worth while to study some of them.

Will (*Berichte* 1914, p. 711) gives results of a somewhat similar study made by him, but merely states that all three isomers have about the same specific gravity, the same temperature of ignition (290-310°C), about the same heat of combustion, roughly 3660 calories; that in the Trauzl block test they give the same expansion and show with the fall hammer, almost the same sensitiveness. He states, however, that the beta isomer is the most, and the alpha the least sensitive to impact, of the three, but that the difference between even these two is so slight as to be of no practical importance.

It is thought that the sand test affords possibly a better method of testing these properties than the tests employed by Will, especially as it is a test of sensitiveness to detonation, which from a military standpoint is highly important. It was, therefore, desired to test the explosive properties of the three more common isomers of TNT by means of the sand test.

Accordingly a quantity of metanitrotoluene was nitrated to the tri stage and the resulting mixture of beta and gamma isomers was separated into its constituents by repeated recrystallization from alcohol. In this con-

nection it might be mentioned that this method seemed to give much better results than the carbon bisulphide separation mentioned by Beilstein.

The purified beta and gamma isomers were subjected to the standard sand test which is a measure at once of the brisance and the sensitivity of an explosive.

The results of sand tests on the alpha, beta, gamma isomers follow:

Material.	Wt. fulminate required to produce complete detonation.	Wt. sand crushed by .40 gram of sample.
Alpha TNT	.22 gm.	30.1 gm.
Beta TNT	.27 gm.	27.2 gm.
Gamma TNT	.23 gm.	29.9 gm.

Curiously enough the order of increasing sensitivity to detonation shown by these results is exactly the reverse of that reported by Will, for sensitivity to impact. This, however, is quite possible, the relation between sensitivity to impact and to detonation being parallel only in a very general way if indeed it should be so considered at all.

The results of these tests show the brisance as measured by the sand test to vary in the three isomers in close accordance with Will's Trauzl block tests, which also are very largely a measure of brisance.

From the above, it is thought that the explosive properties of Grade I TNT could not be appreciably influenced by the amount of beta and gamma isomers that would ever be present.

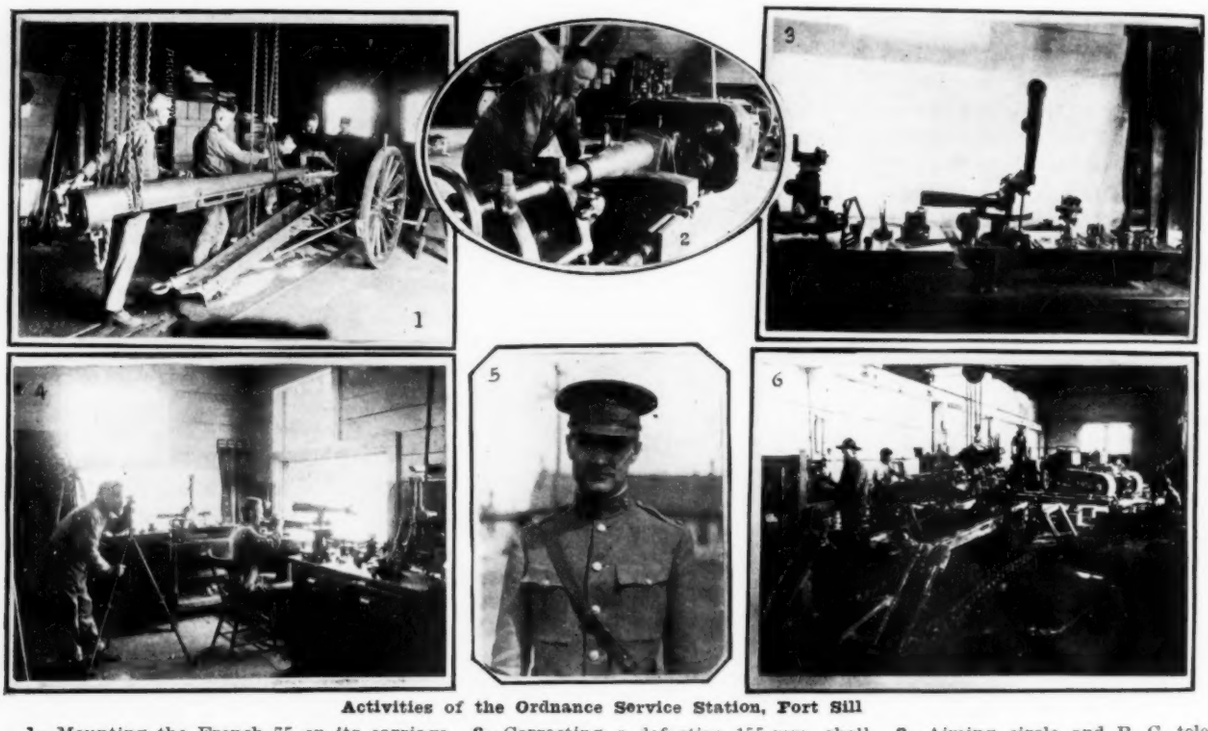
D. M. JACKMAN.

FORT SILL

Ordnance Service Field at Artillery School

IN GENERAL the Ordnance Department supplies the Army the weapons with which to fight, caissons, tractors, fire control instruments, rifles, machine guns and ammunition. The responsibility of the Ordnance Department, however, does not cease with supply. Just as an automobile manufacturer establishes service stations throughout the territory where his cars are used, so the Ordnance follows the issue of its equipment with service stations for the repair and supply of sufficient spare parts to keep the machines functioning efficiently.

The Field Artillery School, the center of instruction of field artillery, requires a wide variety of Ordnance equipment. There is the usual field artillery equipment of guns of many calibers, tractors, caissons and fire control instruments, those of the machine guns, tanks and other weapons for the infantry and the aircraft branches, and machine guns for the air service.



Activities of the Ordnance Service Station, Fort Sill

1—Mounting the French 75 on its carriage. **2**—Correcting a defective 155-mm. shell. **3**—Aiming circle and B. C. telescope, disassembled. **4**—Perfecting fire control instruments. **5**—Major A. J. Stuart, School Ordnance Officer. **6**—Overhauling tractors.

To properly serve all this material presents a more difficult problem than confronts the automobile manufacturer who at most has to deal with relatively few types. Not only must an Ordnance Service Station maintain a corps of highly skilled personnel familiar with all the various kinds of equipment in use, but over 8000 spare parts must be kept on hand in sufficient amounts to meet all requirements.

The Ordnance Service Station of the Field Artillery School consists of a group of shops wherein all repairs are made; and the supply department for handling of spare parts. There is first a general machine shop, then shops for guns, tractors, instruments, ammunition, leather, carpentry, trucks and a paint shop. These are manned by a nucleus of expert civilian artisans assisted by enlisted men of the 9th Ordnance Company. These shops can completely rebuild any guns, tractors or vehicles used by the school, and this becomes very frequent during the course of the year, due to the hard and constant service

received by the equipment incident to normal school operations.

There are required for the Field Artillery School over seventy guns and howitzers from the 75 millimeter to the 9.2 inch, most of which are in daily use. In the gun shop these guns and howitzers and their carriages from one to three at a time, are disassembled, repaired and reassembled and adjusted. A complete overhauling is methodically given each piece every six months. Between these periods other repairs may become necessary which must be completed without in any way disarranging the instruction of the school, which would become necessary if any of the guns were unable to function when called upon.

To haul the guns, howitzers and accompanying vehicles the school uses more than sixty tractors of the 5-ton and 10-ton caterpillar types. The tractor shop takes care of them and will also handle the 6-ton tanks that are en route from Fort Bliss, Texas. Like the guns, the tractors are periodically given an overhauling and emergency repairs made as required. Four tractors can be handled at one time and the shop works to fullest capacity throughout the entire year.

Accuracy is of primary importance in the firing of guns and to control the shooting, instruments of the most delicate sort are required. The Field Artillery School uses 25,000 precision instruments of various types such as telescopes, range finders, aiming circles and field glasses of many kinds. The repair or overhauling of these instruments requires a high degree of skill and specially adapted tools. So delicate are some of the adjustments that sometimes a single operation, such as an adjustment of a pair of reflecting prisms, may take two or three days of careful manipulation. The accuracy of fire of the Field Artillery School has amazed many experts and this success is in no small measure due to the careful maintenance of the Ordnance instrument shop.

A total of over 2600 rifles, pistols, machine guns and automatic rifles are required by the infantry, artillery and air service organizations of Fort Sill. The repair of these weapons is handled by the small arms shop, which also makes a careful inspection of all rifles to detect anything which might prove to be dangerous as supersensitive triggers or excessive head space.

A leather shop is maintained for the repair of web leather and canvas accessories, such as instrument cases, muzzle covers, and the like. The Ordnance also repairs the wooden accessories like arm lockers and fuze boxes.

In addition the Ordnance maintains a machine shop with a variety of lathes, shapers, milling machines, trial presses and other machine tools such as would be found in a commercial general machine shop.

Closely allied with this unit is the blacksmith and welding shop, which handles all forging, welding and cutting work. The oxy-acetylene welding process saves much time and money in the repair of expensive parts which otherwise would have to be scrapped. There are also truck and paint shops employed in connection with the upkeep of various Ordnance activities.

Each year there becomes unserviceable from mechanical damage or chemical deterioration a considerable amount of costly ammunition which can be made serviceable at relatively small expense by disassembling and replacing the unserviceable parts with serviceable ones. This work which involves considerable danger unless proper methods and precautions are used, is done in the ammunition shop. As an illustration, this shop has just completed the assembly of 500 rounds of 75 millimeter shrapnel, representing a saving of about $6,000. Again modifications of ammunition to increase its range accuracy or certainty of functioning, are developed from time to time. Such modification must be applied to the ammunition where it is due to the excessive cost of transportation of explosive material. An example of this is the modification of rotating bands of 155 millimeter projectiles which was found desirable. This work was done on one of the large lathes in the machine shop. Such work must obviously be carefully and intelligently carried out, since an explosion of one shell while in the lathe would wreck the whole shop.

Each year, for the instruction of student officers, field exercises or maneuvers in which actual war conditions are simulated as nearly as practicable, are conducted by the Field Artillery School. Certain exercises illustrate the tactical handling of the artillery in divisions, corps and armies. Such artillery has normally attached to it Ordnance Maintenance Companies which are in effect mobile service stations. During these exercises the 9th Ordnance Company (Maintenance) participates and actually makes repairs on the spot with its mobile equipment in order that artillery officers may become familiar with what they may expect in time of war in the way of service in the field and that utilization may be made of the facilities provided for this purpose.—(*The Guidon, April* 23, 1925.)

SMALL ARMS

National Rifle Matches Will Begin August 22, 1925

THE dates of the National Rifle Matches at Camp Perry, Ohio, have been set from August 22 to September 19, inclusive.

The School of Small Arms instruction will begin on August 22 and continue until September 3. The National Rifle Association matches will begin on September 4 and continue until September 13. The National Championship matches will begin on September 14 and conclude on the 19th.

During the progress of the 30 caliber matches the small bore program (22 Caliber) will be shot. There is some talk of combining all the small bore matches in one week, winding up with the international match with England. The dates for these events will be announced later.

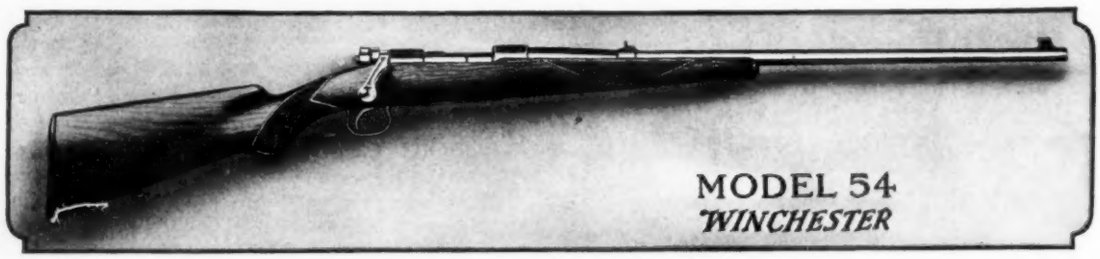
The executive officer of the National matches this year will be Col. A. J. (Sandy) Mac Nab, U. S. A. Colonel Mac Nab knows a great deal about rifle shooting and should make an ideal National Officer. He has hunted big game in Northern Alaska and as far south as Southern Mexico. He took part in the pistol and rifle competitions from 1903 to 1913; was on the General Staff of the A. E. F. in France with general supervision over all rifle training; was in charge of the inter-allied rifle and pistol championships at Le Mans, France, in 1919, and devised the system of rifle and pistol training now in use

in the United States Army and wrote the present Army manuals on these two subjects.

This would indicate that Col. Mac Nab should be able to efficiently handle the gigantic task that confronts him at Camp Perry.

The New Winchester Model 54 Rifle

SOME of the special features and principal dimensions of the New Winchester Model 54 Rifle are as follows: *Calibers*—Standard rifle will be .270 W. C. F. It will be furnished also in .30/06 Cal. when so ordered. *Style*—Solid frame only. *Length*—44¾ inches. *Weight*—About 7¾ lbs. *Barrel*—24-inch round, nickel steel with solid raised lugs for both front and rear sights. *Stock*—One piece, selected American walnut, pistol grip, full fluted comb, forearm and grip handsomely checked; swivel eyes for sling strap, shotgun type cross ribbed steel buttplate. Drop; comb 1 13/16 inches, heel 3 inches, length 13½ inches, pistol grip 3½ inches from trigger to front edge. *Sights*—Specially designed for this arm: Front sight, Lyman Gold Bead; Rear sight, Lyman Folding Leaf with plain U notch in both leaves; 1st leaf for point blank range of 200 yds.; 2nd leaf for about 500 yds. Both leaves fold down flat on barrel. Receiver has screw holes for a Lyman micrometer windage receiver sight, which will be furnished on special order, and lies on the left side of the gun, out of the way of the hand when operating the bolt, and has remo ble peep disc. The leaf sight and receiver sight align with the same height of front sight, and either can be used independently of the other. *Magazine*—Staggered box type, undetachable, charged either singly or from standard clip; holds five cartridges, which with one in chamber places six at command. *Mechanism*—The receiver is matted on the top at front and rear. The bolt is of the up-turn and pull-back type. The handle, being sloped rearwardly and, having an ovoid knob, is specially comfortable and convenient to the hand. Both breech locking lugs at front are sturdy and unslotted. An extra guide lug prevents cramping on rearward or forward movement. The firing pin is cocked on the opening movement of the bolt, by an easy camming action. The bolt can be instantly removed and dismounted for cleaning, or examination of the bore, by an extra pull on the trigger, but will not drop out should this be accidentally done when the action is open. The firing pin is easily removed from the bolt for cleaning, no tools being required. The trigger has a double pull, giving a smooth action, a short, snappy letoff of 4½ to 6 lbs., and the finger-piece is nicely corrugated. The safety lock, at rear of bolt, lies on the right side when in firing position, avoiding danger of striking the face when operating the bolt at the shoulder,



The New Winchester Rifle, Model 54

SPRINGFIELD ARMORY

Preparation of Ordnance Drawings

THIS is a subject which has been given considerable attention of late, and deservedly so. The former method of preparing drawings, the principal feature of which is the use of a uniform size sheet, is ideal for record purposes, but is not well adapted for live production drawings. The tremendous importance of establishing sound mass production methods of manufacture for the greater part of the material covered by Ordnance drawings has led to adoption of the present system which is chiefly distinguished by the practice of showing one detail only on each sheet, and use of sheets of various sizes. This is a step, but only a step, in the direction of development of a system suitable as a basis for manufacture in accordance with modern methods. Careful scrutiny of tolerances has been enjoined—another step in the right direction—but one involving grave difficulties which are very little understood and about which more will be said later. The present prescribed use of unilateral tolerances is another subject upon which some comment will be made in the following part of this discussion.

For some time the writer has been studying the subject of preparation of drawings. Information on this subject is scarce, and exists almost entirely in the minds of those who have informed themselves upon it by observation and experience. These comments are in no wise advanced as original or the result of personal theorizing, but are offered simply as a compilation of some of the more evident facts which bear upon the science, for such it is, of preparing drawings upon correct principles. Particular acknowledgment is made to Mr. J. D. Pedersen for much enlightening comment on this subject.

Before discussing the more basic considerations involved it is desired to offer a few criticisms of the present system, beginning with the discussion of the best system of showing dimensions—decimal, fractional, etc.

In general, the method of indicating dimensions on a drawing should correspond to the method which will be used in constructing the article which the drawing represents. If a scale divided in eighths of an inch is the measuring instrument to be used, the dimensions on the drawing should be shown in eighths of an inch as well; if more accurate means of measurement are to be em-

ployed, the dimensions should be shown accordingly and in the identical units which are to be used in measuring.

Ordnance includes a considerable variety of material produced by widely varying methods, hence there is no possibility of a single system being equally applicable to all articles. If a single system is adopted it must be that most suitable for the largest class of articles and those most difficult to produce in the numbers required, but distinct systems could be adapted to various classes of material. A reasonable solution is that the system of dimensioning be made in each class of material to agree with the usual methods of measuring employed in the production of such material. In general, wooden articles, such as boxes, any article produced by other than machining methods, or articles upon which no gaging is needed to insure correct construction, can probably be best dimensioned using vulgar fractions only. Parts produced by machining processes and requiring gaging comprise a very large class of material. For these there is no choice as to the proper and practical method of dimensioning, which must agree with the measuring system employed. This is the straight decimal system with dimensions expressed in tenths, hundredths, thousandths, or ten-thousandths of an inch with appropriate tolerances. If a single system is prescribed the decimal system must be adopted. In case of articles produced in part by methods requiring decimal dimensions and in part by other methods it is believed that for the sake of uniformity within a single drawing the decimal system should be used altogether but with tolerances applied only to the dimensions requiring gaging.

In any system, a decimal and a vulgar fraction should never be shown together. If they agree, there is no necessity for both, and if they do not agree there is no means of determining which shall govern. Such practice violates the basic essential of all dimensioning which is the delineation of exact information. The uselessness of fractions in addition to decimals, the extra work of noting them upon a drawing, and their adverse effect upon the appearance of the drawing are other objections to their use, though of lesser importance than the main disadvantage just noted.

It is believed that the present method of indicating the type of finish desired is not satisfactory, and the writer is not aware of any method which would be. To a very considerable extent the tolerance allowed on a machined surface will govern the finish which will result from the machining operations. As finish marks are applied to machined surfaces only, it would seem that they are unnecessary and should therefore be eliminated.

The use of unilateral tolerances is now prescribed, and works out well except for such dimensions as the location of holes. While it is true that the correctness of the maximum and minimum limits shown, regardless of the system used, is the basically important consideration, it is firmly believed that use of bilateral tolerances for such dimensions would be of advantage and without any adverse effects. Uniformity alone is not sufficiently important an object to necessitate rigid adherence to the unilateral—or any other—system.

There has been some discussion relative to the advisability of placing tolerances on dimensions showing radii. Even a brief analysis of this question will show that all radii are not in the same class. Fillets joining machined surfaces result from the shape of the cutting tool, and this is true also of some classes of convex curves. In such cases the allowable variation must be specified, not with the idea of gaging the results exactly, but simply as a guide in selecting the cutting tool and in allowing for reasonable wear rather than leaving these points unsettled, with attendant costly attempts to work to a flat dimension. In many cases the radii of concave curves need only be given as the maximum, with no minimum limit. Where applicable, this is a very convenient method and has the advantage of greatest simplicity combined with exactness of information. Its use should be permitted. Some concave curves, and convex curves in general, require both maximum and minimum limits, which limits should be as liberal as possible. They will not ordinarily be gaged, but will serve simply as a guide in selecting or preparing the cutting tool or indicate the approximate results desired if the curve is to be formed by other means, as by hand.

It has been customary to show convex and concave corners as sharp, sometimes with the general note "Break corner." Frequently these corners mate, and a very natural condition is that, due to wear of the tool which forms the concave corner, this corner is automatically filleted, whereas the convex corner may be very nearly sharp. In small pieces, removal of only a little of either corner is permissible, and in many components there are so many of these corners that to show them in detail with dimensions would greatly complicate the drawing or necessitate a larger scale or both. The practice seems to have been to dimension corners or fillets of .03 radius or more. Those less than this are not usually definitely expressed, but are, nevertheless, frequently quite important. In such cases, it is believed that a bevel is preferable to a curve, the main object being provision of clearance and avoidance of sharp concave corners which might start cracks in heat treating. It is suggested that the present rather indefinite general note "Break corner" be superseded by a legend showing for convex corners a 45° bevel, with limiting dimensions of .01 and .015 from the vertex of the angle, and for concave corners a 45° bevel with corresponding limiting dimensions of .005 and .01, these to apply generally to all corners not otherwise specified, and this legend to be printed on the tracing.

The proper preparation of drawings of an article to be produced by machining processes and requiring limiting tolerances for its various dimensions is an extremely difficult task, so much so in fact that even the difficulty involved is not at all generally appreciated. It requires exact knowledge of the machines and methods suitable for each operation, which knowledge is seldom possessed by the draftsmen who do the actual work of drawing preparation. For this reason it is believed that drafting regulations should include at least an elementary discussion of the theories and principles involved and essential practical information such as the variations from exact accuracy inherent in the various usual machining operations. Of the principles involved, those of the relation of the holding points to the arrangement of dimensions, the importance of this arrangement in indicating the process to be followed, and the necessity for agreement of each individual operation and its check by gaging with

the corresponding drawing dimensions, are vital and all too little understood.

There are two stages in the development of successful design for an article such as a firearm which is to be produced by mass production methods. They are: Development of the inventive or experimental design without special regard to manufacture and, subsequently, development of the manufacturing design which will combine satisfactory functioning with suitability in all respects for economical production. The second of these two steps has not in general been even recognized in the development of the design of the most of our military firearms. The history of the development of these is typically the application of a "cut and dry" method, accompanied by some diagrammatic drawings showing principal dimensions without tolerances and without reference to holding points. Frequently, more faith is placed in models than in drawings. Later, component drawings may be prepared, first to flat dimensions, with later modification by arbitrary addition of tolerances which look about right, but still with no consideration of the process to be followed and with blithe disregard of special conditions which the application of tolerances involves. This very fairly represents the present status of many small arms and automatic arms drawings and indicates the fundamental reasons for their unsuitability for production use. It would not be far from the truth to say that the most of our present designs are about at the end of the experimental stage, with the manufacturing design of each still to be prepared.

The first step in preparation of a drawing is formulation of a definite plan to be followed in making the article the drawing represents. Each operation must be clearly visualized, together with the machine and tool which will perform it and the means of holding the work while the operation is being performed. The sequence of operations must be definitely established. The basic fact to be borne in mind in this connection is that in general all dimensions must lead from the holding points. This is vital, and the reason for it is that while a given operation is being performed the dimension which is directly controlled, and the only one which is controlled, is the distance between the cutting edge of the tool and the holding point. (Buckingham, "Interchangeable Manufacture.") It is obvious, then, that the dimensions upon the drawing should be arranged to conform to this principle, and it is equally obvious that the check of the correctness of the operation by gaging should be so performed that the exact dimension established in the work by the operation, and this dimension alone, is verified. It is believed that violation of this principle in small arms work has generally been the rule rather than the exception.

In general, dimensions must lead from the holding points, but there are some exceptions to this rule, two of which deserve special mention. They are those involving the dimensioning of a slot or the like which is determined by the size of the tool itself, in which case location of the slot or similar feature from the holding point, supplemented by a subdimension, establishing the remaining feature, such as slot width, is the correct method. It will also be apparent upon consideration that this method applies generally to such operations as straddle milling or multiple operations performed by gang cutters. These are the important exceptions to the general rule. There may be others; the subject is by no means exhausted in these few brief comments, but these seem to deserve special mention.

The holding point is generally the basis for all dimensioning. It is not sufficient, however, to select arbitrarily three sides as reference surfaces and base all dimensions on them, although this method would be preferable to the prevalent one involving intermediate dimensions with attendant accumulating tolerances and lacking any indication of the holding points to be used. It is important to note that the holding point for one operation may be impossible for use as the holding point for another. It is, of course, desirable that a single set of holding points be used throughout the processing of a part, and this consideration provides ample scope for the exercise of ingenuity by the designer. However, in cases which do not permit of use of the same holding points for all operations, those actually used must serve as the base for their respective group of dimensions. This is an extremely practical matter which is definitely related to the fact that while an operation is being performed the dimension which is actually being established in the work leads from the holding point to the cutting edge of the tool, as mentioned above. At first glance, arrangement of dimensions in accordance with this principle may seem round about and difficult in checking, but careful consideration shows the bald necessity for it, which boils down to the fundamental that the drawing and the process must agree.

Intelligent application of tolerances to the dimensions shown on a drawing is an art in itself, and one not generally understood. Tolerances are necessary because of the impossibility of producing exact dimensions or, indeed, of measuring them even if they could be produced. Their use implies an inherent variation in the results of repeated like operations. This variation, however, is not to be considered as inaccuracy, since within the limits which the tolerances prescribe one size should not necessarily be preferred to another. The function, then, of tolerances is to prescribe acceptable variation which will include the natural unavoidable variation inherent in the process used. The first step, therefore, in prescribing a tolerance is consideration of the normal machine variation which may be expected from the method of performing the operation which the tolerance is to govern. A tolerance of plus or minus .001 for a dimension established in the work by an operation having a normal variation of .005 is not only idle but vicious in that the drawing is to this extent automatically disregarded. Discredit in part soon leads to discredit as a whole, and the net result is that the drawing soon occupies the place of an irritating appendage of the process rather than that of a basic specification. Lack of definite information covering the variation which may be expected in machining operations leads to close tolerances on the drawings, with results as just noted; the only remedy for this is instruction.

With consideration of the degree of variation inherent in the available machining processes as a basis, the next step in determining a tolerance is the variation permissible in the product, which must in any case be at least equal to the process variation. It should be somewhat

greater, although no fixed rule on this point can be laid down. Increase of tolerance beyond a comfortable margin over natural and reasonable process variation is of little benefit. Determination of allowable variation is a function of design, and about all that can be said in general upon it is that each case must be decided upon its merits. The main difficulty arises when the apparent permissible variation is exceeded by the variation inherent in the means of production. Under these circumstances three courses are possible. They are: development of other means of production, the natural variation of which falls within the permissible variation; modification of the design to allow of greater variation; or both. One of these three things must be done: there is no other possibility which can result in a correct drawing.

Closely related to the consideration of normal process variations is the method of holding the work and particularly its effect in increasing this variation. The two general methods are, as is well known, holding in a vise by friction only, the work being located against stops; and holding in a similar way but with the work located upon pins which seat in holes prepared for them. It is believed that the second method is preferable, and that its use when applicable should be favored, if not, indeed, prescribed.

Determination of individual tolerances or pairs of tolerances upon the principles outlined above is but the first step in corelating the tolerances of mating parts, which process requires check of all combinations of maximum and minimum dimensions to determine whether the required conditions of fit and clearance are insured. The first attempt will seldom in all respect produce the result desired, in which case successive approximations must be made until the required conditions are obtained. For simple parts having few mating surfaces this process is not difficult, but for complicated parts having many mating surfaces this analysis is exceedingly complex, is little understood, and apparently has seldom been attempted. This is significant when viewed in connection with the extreme difficulty which has generally been experienced in preparation for mass production of a new model of firearm and the lack of uniformity among supposedly like products turned out by different plants.

WALTER T. GORTON.

WATERVLIET ARSENAL

Modern Gun Relining Methods

IT HAS been the common experience of all plants engaged in the manufacture of Ordnance that one of the most difficult problems presented is to obtain a perfectly satisfactory assembly of a liner to a tube or gun, by shrinking. In guns where the shoulders are located adjacent to or forward of the origin of rifling the chief difficulty has been to assemble the gun and liner in such a manner that the corresponding shoulders are properly seated. This difficulty is due to the fact that the hot gun enveloping the cool liner causes the latter to expand and contract with the gun at a number of places along its length, before the desired contact is made at the breech. As the gun in cooling contracts longitudinally as well as diametrically it is obvious that if the tube grips the liner at a point forward of a shoulder, that as the gun shortens the shoulder of the tube will recede from the shoulder of the liner, leaving an undesirable gap between the shoulders; while on the other hand, if the tube grips the liner to the rear of a shoulder it follows that the shoulders will be drawn together as the gun cools. Again if the gripping were to occur at the extreme breech end, the result would be an excess forcing of shoulder on shoulder, which would create an overcompression or staving up of the metal over the powder chamber.

To meet and overcome this problem the Watervliet Arsenal adopted a method in which it has been uniformly successful. The procedure is as follows: The gun is placed in an electric furnace muzzle down and heated to the required degree. The liner is fitted with a water plug screwed into the muzzle end and a lifting plug fitted to the breech end through which a water inlet pipe enters the cavity of the liner and extends downward, close to the bottom. An overflow pipe fitted into and through the muzzle plug extends upward to a point just below the contact shoulder. When the water is turned on it enters through the inlet pipe rapidly filling the liner to a point just below the contact shoulder where it escapes through the outlet pipe. The liner is thus filled with water to the level of the overflow pipe before assembling.

When the gun is heated to the required temperature, the current is shut off, the furnace opened and the liner lowered into the gun to its shoulder. The water circulating in the muzzle section keeps this part cool and consequently free from contact, while the breech section which contains no water, expands rapidly and grips the gun. The water is allowed to run for three hours, when it is turned off. The gun is left to cool in the furnace. This method is very effective in securing shoulder contact.

Recently an order was received at this Arsenal for the manufacture of nine 8-inch Naval Guns which presented a problem in the assembling of liners very different from the methods heretofore employed. The problem consisted in shrinking a liner where the contact shoulder was within three inches of the breech end of tube and liner.

It should be noted that heretofore no hydraulic or other external pressure has been applied at this Arsenal to keep liners on shoulder in assembling. As the solution of the problem involved the perfect gripping of the tube and liner and seating of this first shoulder and thereafter establishing contact of liner and tube progressively away from the contact shoulder, it was evident that other means than those heretofore employed must be devised.

To accomplish this a stand pipe having a number of relief valves was designed, the salient features of which are shown in the accompanying sketch, Figures 1 and 2. The stand pipe A which is held central to the bore by two centering supports is fitted into and extends through the muzzle plug—B—which is screwed into the muzzle end of liner. The stand pipe is secured in the muzzle plug by a device B-1 which acts both as a chuck and packing gland. On the stand pipe are attached ten valves —C 1-2-etc.—each of which covers an opening approximately equal to the area of the pipe and which are numbered and operated successively from the top down by a set of wires—D—which are correspondingly numbered and tagged. These wires extend through the lifting head

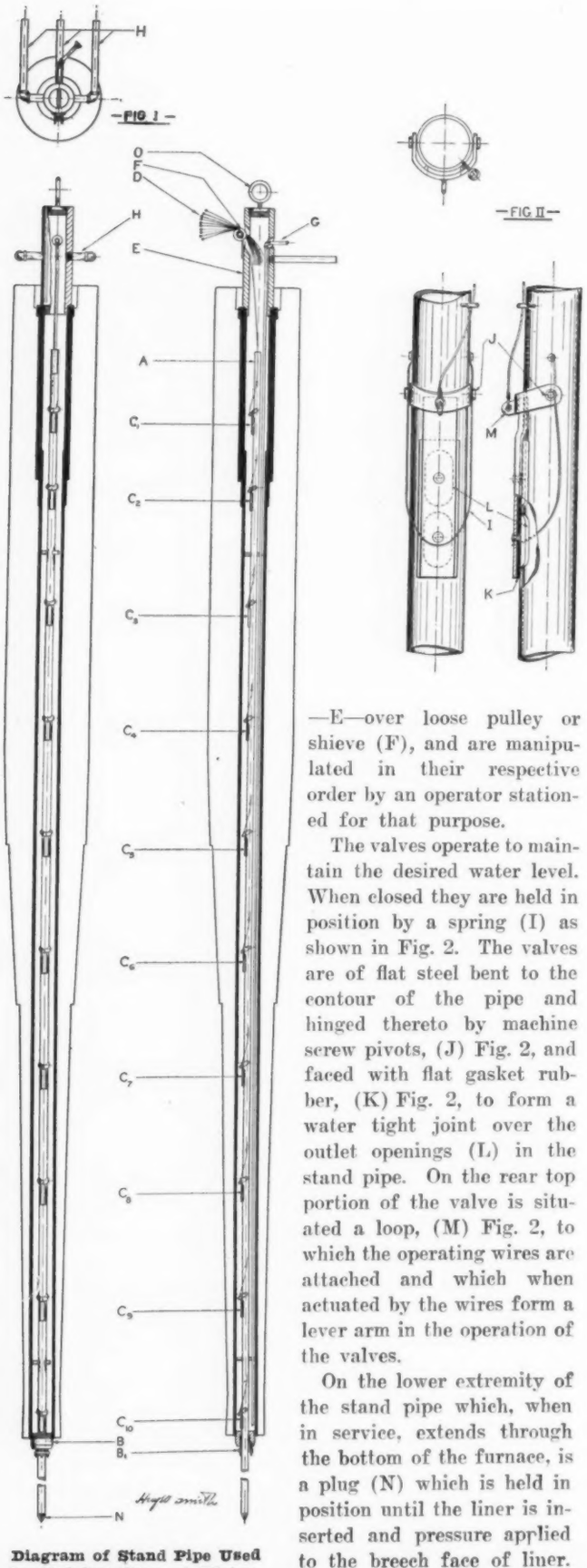


Diagram of Stand Pipe Used in Relining Guns at Watervliet Arsenal

—E—over loose pulley or shieve (F), and are manipulated in their respective order by an operator stationed for that purpose.

The valves operate to maintain the desired water level. When closed they are held in position by a spring (I) as shown in Fig. 2. The valves are of flat steel bent to the contour of the pipe and hinged thereto by machine screw pivots, (J) Fig. 2, and faced with flat gasket rubber, (K) Fig. 2, to form a water tight joint over the outlet openings (L) in the stand pipe. On the rear top portion of the valve is situated a loop, (M) Fig. 2, to which the operating wires are attached and which when actuated by the wires form a lever arm in the operation of the valves.

On the lower extremity of the stand pipe which, when in service, extends through the bottom of the furnace, is a plug (N) which is held in position until the liner is inserted and pressure applied to the breech face of liner. Into the breech end of the liner is firmly screwed the lifting head (E). This is an important part in that it is not only a lifting plug but acts as an extension of the liner, with circulating water. It is also a housing for the inlet pipe (G), three outlet pipes (H), the lifting ring (O), the outlet for the valve operating wires, and is also used as a base for the application of the external pressure.

The gun is placed in furnace, breech end up, resting on pedestals, and is heated to 400°F at breech and 550°F at muzzle. The heat is gradually brought to these temperatures in fourteen hours and held for thirteen hours, total heating time twenty-seven hours. The liner which had been previously thinly coated with oil and graphite is suspended in the crane and filled with water to the level of the overflow pipes (H) in the lifting head. A small cover is then removed from the top of furnace and through this opening the shop inspector ascertains the dimensions at the top of the liner seat. If sufficient expansion is found, the liner is entered and lowered to the seating shoulder. The inlet pipe is then connected and water turned on which immediately causes an overflow at the upper outlet pipes (H). By this circulation the liner is entirely filled with cold water until the lifting ring (O Fig. 1) is removed and a pressure of 175 tons applied to the upper face of the lifting head. At this juncture the plug (N) is removed from the bottom of the stand pipe (A) and the water in liner immediately drops to the level of the top of stand pipe (which is located approximately 16 inches from the breech end of liner). It is held circulating at this position for ten minutes, after which valve No. 1-(C_1) is opened and the water level in the liner is dropped to thirty inches from the top of stand pipe where the water is held (still circulating) for seven minutes, then dropped thirty inches to the next lower level, where it is held for five minutes. This process is repeated, the time at each succeeding station being gradually reduced to 4, 3, 2½, 2, 1½, and 1 minute, respectively. This lowers the water level to the muzzle end, the water being continually circulating. During this process heat is retained in the four lower sections of the furnace and the temperature of the water at the outlet is taken and registered at intervals.

By this arrangement it is possible to direct and control the progress of contact between the liner and tube, the liner being kept cool and consequently free from contact by the circulating water up to its level while the preceding upper sections, from which the water has been released, is permitted to expand and engage the tube progressively.

The method of shrinking liners, which was originally devised to meet the requirements of the Naval order mentioned above, has proven to be correct in theory and in practice. It is understood that this method has now been adopted and is employed at the Naval Gun Factory in Washington.

HUGH SMITH.

Editor's Note: In connection with the above description of "Modern Gun Relining Methods," attention is directed to articles on the same general topic which appeared in ARMY ORDNANCE, Vol. IV, No. 22, January-February, 1924, page 256, "Removing Liner from 14-inch Gun," and Vol. V, No. 25, July-August, 1924, page 472, "Relining 14-inch Gun."

Book Reviews

John Edson Sweet. By Dean Albert W. Smith. Philadelphia: American Society of Mechanical Engineers. 1925. Morocco $7.50, Cloth $3.75.

PROFESSOR SWEET, the subject of this biography, had a greater number of intimate personal admirers and friends than is allowed to many of us in this world. He had that quality of charm which attracted and held all who came under his influence as students, workmen or associates. Yet not one of them felt equal to the task of writing the story of his splendid life, fearing his own inability to adequately satisfy the multitude of other admirers. A group of them finally agreed to act as a committee to assist Dean Smith, of Sibley College, Cornell University, the selected biographer. The A. S. M. E., which owes its birth largely to this eminent mechanical engineer and which honored him with its highest office, underook the publication of Dean Smith's work. With the Committee, the Dean and Calvin Rice, the Secretary of the A. S. M. E., behind this book—well—it just had to be good.

The Dean has done a good job. He has made the Professor stand out, as he stood in real life, a lovable, interesting, inventive, respected and dominating man; devoted to high principles of living, design and of business, yet not parading them offensively; filled with a conviction that his life purpose is to do good where his shadow falls, yet doing that good quietly and happily, and confident always of a better way to design every mechanical device, yet stopping his inventing now and then to give the world a better tool than its old one. The Dean spends his whole first chapter introducing the man with whom he takes you on his little journeys among the cities of the world, in their machine shops, drafting rooms and laboratories. In these, later on, he will present the great makers of mechanical tools and appliances of the last sixty years, men who were the friends of Professor Sweet.

I hardly know in what role you will like Edson Sweet best, but in some phase of his life, you will find he has touched with powerful hands your favorite work. College men will like him best at the bench in his shop at Cornell, a dozen students around him, asking of his great experience in the English shops of Birmingham and London, and receiving more than they ask. Architects will wonder that this mechanical genius should have designed that pretentious Moorish Hotel at Selma, Alabama. Consulting engineers will appreciate his generous spirit in forming the A. S. M. E. to disseminate the knowledge of mechanical design. Shop superintendents and managers will think of him as the maker of accurate standard gages for American production methods and of the first planer-miller, called the traversing machine. Designers will remember his sense of proportion, his graceful blending of straight lines with curves, the smoothness and symmetry of his products. Power plant men, who have used the old straight line engine, will speak of the reliability of his equipment. Ordnance officers will recollect his connection with the Semet-Solvay Company, whose knowledge and processes for making the ingredients of explosives meant so much to us in the uncertain days of preparing an unprepared country for its greatest battle. And his "boys," those hundred or more men who honored him once each year with a great, happy, reminiscent dinner together in New York or Syracuse, will just remember a sincere, generous, great minded friend.

The Dean takes one along with the Professor rather rapidly, spending little time on his family connections and early days; too little, I am afraid, on his great achievements in many fields. Hardly any space is devoted to the many long journeys all over the globe, but at the end of the book he quotes some very good letters from his trips in and around the Mediterranean, written in his seventy-third year. They show the keenness of mind, the enthusiasm for life, which he retained three years after the allotted three score and ten.

But then, one volume could never cover all of his life time. Professor Sweet did too many things that were worth while to record. You feel, however, when you have finished the last page of this big neatly printed volume, that you ought to know more of this kindly gentleman, who wanted to know you, who engraved in stone over his shop door, "Visitors Always Welcome."

It is a pleasure to find a well illustrated book printed so accurately and readably on light unglazed paper.

C. G. METTLER.

The Fundamentals of Statistics. By L. L. Thurston. New York. The Macmillan Company. 1924. 237 pages.

THE ever-increasing use of statistics in books and articles on educational subjects is admitted by every one. These statistics must be analyzed by the reader, and to do this properly the author of this volume believes there are certain fundamental laws which must be correctly understood. These laws which make it possible for anyone to make logical interpretations of statistical data form the basis of the book.

As a professor of psychology with seven years' experience in teaching the principles of statistics, the author is well qualified to write a text-book of this nature. His method of treating the subject is to develop in the reader a logical process of reasoning whereby the many implications of statistics will have a more complete and comprehensive meaning. Numerous examples are furnished

and many problems stated for solution. It is quite probable that those who will read and study "Fundamental Statistics" will discover facts and angles pertaining to statistics which they have never fully considered.

While the author assumes that the student may have forgotten most of his algebra and has, therefore, made his explanation simple, nevertheless the development of the text does involve higher mathematics and requires a more or less well-trained mind in the fundamentals of logic to fully appreciate or comprehend the processes of reasoning set forth. This is evident from the subjects treated which consist of linear relations, non-linear relations, equation of a straight line, arithmetic mean, binomial expansion, probable error and similar terms. The volume does not consider the choice of methods of presentation.

Physikalisches Handwörterbuch (Physical Dictionary). Edited by Arnold Berliner and Karl Scheel. Berlin: Julius Springer. 1924. $9.30.

THIS work is intended as a reference book for physicists who wish to inform themselves on subjects outside of their own special fields of endeavor as well as for those in other branches of science and engineering who use physics as an instrument in their work. It is well planned and the subject matter is presented in a clear and concise manner. The names of the 59 contributors are a guarantee that the text is accurate and authoritative.

About 3,500 subjects are covered in 2,500 articles. The subjects are arranged alphabetically with cross references to articles. References to the literature of the subject are given and all articles are signed by the author. The average length of an article is 350 words, though many articles are much longer. The volume is well bound and profusely illustrated; there are 573 illustrations in all.

To the physicists and other scientists and engineers for whom this book was written it will supply a long felt need provided they have the requisite knowledge of German. For the benefit of those whose knowledge of German is deficient, it is to be hoped that an English translation will be published. The book will doubtless prove to be of great value to all those who are engaged in research in physics and related subjects and should be on the shelves of all technical libraries which cover the field of physics.

Impressions of Great Naturalists. By Henry Fairfield Osborn. New York: Charles Scribner's Sons. $2.50.

THIS story by Henry Fairfield Osborn, Research Professor of Zoölogy in Columbia University and President of the American Museum of Natural History, is full of reminiscences of the great naturalists, Darwin, Huxley and others. Professor Osborn is well qualified to write this book, as he is exceptionally familiar with the life of naturalists, explorers and authors of creative work. Among other books written by Professor Osborn may be mentioned "Men of the Old Stone Age," "The Origin and Evolution of Life," and other books of a similar nature.

The present volume is made up of twelve lives of great naturalists chosen from fifty-seven biographic sketches of men and women that have been written by Professor Osborn. Among these twelve he includes Roosevelt, Bryce and Butler because they were explorers and observers who showed some of the highest qualities of the naturalist. These impressions are full of local color inasmuch as Professor Osborn, as a student, was probably as eminently connected with Huxley, and to a lesser extent, Darwin, as anyone of the present living naturalists. Some of the chapters in the book are based on articles published in current magazines, such as "Popular Science Monthly," "Science," "The Century" and "The Sierra Club Bulletin." The volume is well illustrated with portraits. These reminiscences are very readable, touching as they do upon the lives of men of such prominence and scientific attainments as Darwin, Pasteur, James Bryce, Theodore Roosevelt and John Burroughs.

The book might be described as stories of genius, devotion and self-sacrifice. These great men, as the author shows, were driven on, not by ambition but by love of fellowmen, love of profession, love of beauty and truth.

The History of Munitions Supply in Canada, 1914-1918. By David Carnegie. New York: Longmans, Green & Co. $6.00.

THIS volume is a welcome addition to the bibliography of industrial achievement under the stress of war-time conditions. Written by Col. Carnegie, Ordnance Adviser to the original Shell Committee and later to the Imperial Munitions Board, himself an engineer and metallurgist, this book has well accomplished its purpose in recording and preserving accurate and interesting facts of a remarkable achievement by Canadians upon which the statistician may rely and of which the British Empire may be justly proud.

The book is more than a mere collection of facts—it is an epic of Canadian patriotism and industry, and pays fitting tribute to the men who made success at the front possible by their sacrifices at home.

The history of Canada's munition effort is the history of two great voluntary organizations—the Shell Committee, and its successor, the Imperial Munitions Board—both of which were improvised under the stress of war. When it is remembered that no private manufacturer had ever made a shell in Canada prior to the outbreak of the war, that national resources had to be developed and new industries introduced, that Canada succeeded in meeting the demands placed upon her industry by the Empire, and that all her British contracts were liquidated without a single instance of litigation—the monumental proportions of her effort may be realized.

A Foreword by the Rt. Hon. David Lloyd George and an Introductory Note by Sir Joseph W. Flavelle, Bart., Chairman Imperial Munitions Board, preface this history of Canada's great achievement.

The Hodsock Ballistic Tables for Rifles. By F. W. Jones, O. B. E. With an Introduction by Lieut-Col. H. Mellish, C. B., V, B. And an Appendix on The Ballistic Pendulum by Col. Lord Cottesloe, V. D. London: Edward Arnold & Co. 1925.

DURING the year 1897 and 1898 an extensive series of small arms firings took place in the private range of Lieut.-Col. H. Mellish at Hodsock Priory. Remaining ve-

locities at various ranges were measured by the Metford-Cottesloe Ballistic Pendulum. In 1922, F. W. Jones became aware, as a result of comparative tests with electric chronographs, of the considerable precision that is attainable with the ballistic pendulum and decided to calculate ballistic tables on the basis of the firings made in 1897-98. These tables are the occasion of the publication of the small book which has the title "The Hodsock Ballistic Tables for Rifles."

After it has been shown that the existing Shoeburyness ballistic tables based on artillery firings are unsuitable for small arms projectiles, the author proceeds to explain the method of calculation of the ballistic tables, which are of the Siacci type and indicates how they may be applied in solving the ballistic problems of the rifleman. There follows an account by Colonel Lord Cottesloe of the principles of construction and method of use of the Metford-Cottesloe ballistic pendulum. At the end are given the ballistic tables which give functions for the calculation of the distance, time, and elevation in terms of the initial and remaining velocity.

The evidence which is presented to show that the Shoeburyness tables fail to give the proper shape of the resistance function is convincing. It is also very certain that our own ballistic tables are most unsatisfactory for small arms projectiles. The assumption that their unsuitability is due merely to the fact that these tables are based on firings of artillery projectiles is incorrect, as is also the assumption that the Cranz resistance function is incorrect because it differs from the Hodsock function. Sufficient determinations of resistance functions have been made to show that each shape of projectile has its own resistance function. The evidence also indicates that the resistance function is affected much more by changes in shape than by changes in the dimensions of projectiles. Although ballistic tables based on a modern projectile shape may become obsolete as the shapes are changed they should be in general much more satisfactory than tables based on shapes which are now obsolete.

The range tables of the Ordnance Department are based on actual firings, and thus the range elevation curve corresponds pretty closely to the actual facts of the case whatever resistance function is used. The range corrections, however, are calculated from the resistance function, and if the resistance function fails to correspond to the actual projectile used, the calculated corrections are in error.

On page 37 it is assumed that the time of flight from the vertex to the target is that of a bullet which is allowed to fall to the ground having a zero component of horizontal velocity. This is of course an error. The assumption would be true if the resistance were a linear function of the velocity.

On page 41, evidence is presented which indicates that the resistance of a boat-tail projectile is less than that of a flat base one at high velocities as well as at velocities below that of sound. These results are corroborated by the experiments which have been carried out at Aberdeen Proving Ground.

Because of the signal success which the author has had with it, he is perhaps too much inclined to favor the ballistic pendulum as a means of investigating resistance functions. It is quite possible that data of like or superior accuracy might be obtained by other devices without a greater expenditure of effort. Nevertheless the results presented in this book are interesting and important because they show that it is possible to obtain with a simple ballistic pendulum, data for the construction of a resistance function which are of a satisfactory accuracy.

Medical Aspects of Chemical Warfare. By Lieut.-Col. Edward B. Vedder, M. C., U. S. A. Baltimore: Williams & Wilkens Company. 1925. $6.50.

COLONEL VEDDER is one of the best known authorities on the toxicology of chemicals in the American Army. His work during and since the World War was accredited the highest praise both in this country and abroad, so that this comprehensive treatise on the medical aspects of chemical warfare is the work of an authority whose opinions and findings carry great weight.

Beginning with an outline of the development of chemical warfare as it was used in the latter stages of the World War, this portion of the book has an historical value equal to any of the histories of the subject that have yet appeared. In Colonel Vedder's treatment of the subject, of course, it is merely introductory to the broader considerations of his topic. The greater part of his work is devoted to discussions of the various gases developed thus far, including the pulmonary irritants, the vesicants, and the lacrymators. On each of these subjects the author describes the substances and the properties which make them so effective. He also discusses the counter-irritants that can be used to nullify or at least lessen their deadly effect.

The latter part of the book is devoted to topics connected with the organization of the Medical Department of the Army for the treatment of gas casualties, and there is a concluding chapter devoted to the subject of naval aspects of chemical warfare.

Public Finance. By Harley Leist Lutz. New York: D. Appleton and Company. 1924. $4.00.

THE name of Harley Leist Lutz as the author of a treatise on public finance is sufficient guarantee that the subject is fully and accurately treated. This volume by the Professor of Economics at Leland Stanford, Jr., University, ranks with his other authentic text on "The State Tax Commission." In the present work he has chosen a subject of growing importance not only for the executive who has to manage the finances of his own organization but for all those upon whom the weighty hand of taxation is laid by federal, state and municipal government. Since this latter category includes practically all of us, this text on public finance should have a very broad appeal.

Too often a work of this kind has page after page which savors of the college text book. While this work could be very well used for such purpose, the method of treatment takes it out of such a class and places it among the most interesting subjects with which finance is related. There are a great many topics discussed which, it is quite certain, the rank and file even of financiers are not familiar. After all, public finance as we have it today is such a new development and the ideas which underly it are subject to such constant change that an

up-to-date treatise such as Professor Lutz has written must of its nature contain new ideas some of which are not generally known or understood.

Under the heading of "Taxation" many theories are analyzed, some of which have from time to time been advocated and are here discarded. Under the heading of "Credit" there are many chapters which give one a keen insight into the actual basis upon which all of our state financing is based, while the most important and certainly the most novel portion of the book is reserved for Part 6, in which a chapter on the "Budget," containing the very latest comment upon our federal budget system and our federal auditing reform, are included, so that this volume has the advantage of a text book and an interesting treatise, both of which combine to make it a very valuable book on public finance.

Field Artillery Manual, Vol. I. By Lieut. Arthur Wilson. Menasha, Wis.: George Banta Publishing Co. 1925. $3.50.

THE need for a compact, comprehensive book covering the various Field Artillery subjects has long been felt, particularly among the Field R. O. T. C. units, practically all of which, according to information received from officers on duty with the various units, will adopt this text the coming school year.

Not only does the Field Artillery Manual cover all the subjects prescribed by War Department orders for Field Artillery R. O. T. C. units, but it also contains additional material which broadens its scope to include the essentials of what a battery commander should know, thus rounding out the Manual and making it answer the purpose of a general, all-around book, complete in itself, for Field Artillery officers of the Regular Army, National Guard and Organized Reserves.

Volume I includes all the fundamentals of military training and the basic subjects of Field Artillery that are taught in the first two years of the R. O. T. C., presented in a form that will hold the interest of the student and encourage his endeavors. Full advantage has been taken of the fact that the book will be used by university men who have the advantages of higher education. Included are many interesting references of educational value in addition to the purely technical and tactical subjects of Field Artillery. This will bring home to the student the fact that the history of his Country and its military arm are inseparable and that the technical subjects of armament are in reality part of the university curriculum.

One of the features of the book is the section on ordnance matériel. Fire control instruments, explosives and ammunition are taken up in detail from the point of view that will interest Regulars and Reserves alike. The history and development of artillery from the earliest times and a brief account of the weapons manufactured by the Ordnance Department for use by the U. S. Field Artillery are given. The general principles of design and construction of guns and of carriages are explained and a detailed description of the French 75-mm. gun is given. All types of guns used by the Field Artillery are discussed, but because of their importance as type guns, principal treatment is devoted to the French 75-mm. gun and the 155-mm. howitzer. A great many simplified drawings make these chapters especially well adapted to teaching.

The Recovery of Gasoline from Natural Gas. By George A. Burrell. American Chemical Society Monograph Series, published by the Chemical Catalog Company, Inc., New York City. $7.00.

THIS is a remarkably complete and detailed discussion of the natural gasoline industry from the time of its inception in 1904 up to the present. The author has outlined the development of the industry through a resumé of the different processes that have been responsible for its growth.

Detailed descriptions of the several methods of gasoline extraction are given and there are numerous plates and drawings of plant equipment and layouts. Operating instructions, construction and operating costs, with ample supporting data, complete an excellent account of current practice.

Recognizing the importance of good engineering practice in economical and efficient plant operation, the author has included chapters on fractionating columns, gas engines and compressors, steam boilers, the steam engine, pumps, water cooling systems, pipe for natural gas plants, tanks, regulators, relief valves, traps, thermostats and meters, and fuel economy. Chapters on chemistry of natural gas, analysis of natural gas, measuring natural gas, testing gasoline, and quality of gasoline cover this phase of the subject in a clear, concise manner.

Such chapters as "Occurrence of Gasoline in Natural Gas," "Origin of Petroleum and Natural Gas," "Gas Leases," "Losses in Shipping Natural Gas Gasoline," "Gasoline Loading Apparatus," "Insulating Gasoline Storage Tanks," "Development of Transportation," "Accidents in Transporting Natural Gasoline," "Depletion of Natural Gasoline Properties," "Other Motor Fuels Than Gasoline," and "Quality of Gasoline Marketed in the United States" add to the general interest and value of the book.

History of Political Thought. By Raymond G. Gettell. New York: The Century Co. 1924. $3.75.

THE need for an analysis of the principal political thought of past generations has been apparent to anyone who has attempted to delve into the storehouse of information existing in our text books of the present and immediate past. To so inquire has always resulted in a task, the strenuousness of which has often won out over the perseverance of the seeker with the result that many facts and theories have remained undiscovered and undescribed. Americans especially are prone to believe that their own political system which has so nearly attained an ideal form, while generally conceded to be the best, was "struck off," as has been said of the American constitution in the twinkling of an eye, and without regard to the systems of the past. That this belief is utter folly is proved by the perusal of such a volume as Professor Gettell has prepared in his "History of Political Thought."

Here is a book for analyzing the doctrine of leading political thinkers from the earliest days down to our own

time. The ancient civilizations that attained their heyday of prosperity and are long since forgotten are adequately described and commented upon. The more modern forms, some of which have outlasted the trials and tribulations of modern diplomacy and war, are likewise analyzed from an entirely objective point of view.

We cannot help but call attention to Professor Getteli's style which, while clear and definitive throughout, oftentimes takes for granted at least some fundamental doctrines which all are not yet ready to concede. Thus on page 8, where he says "Only recently have the expansion of historical knowledge, the rise of a critical historical attitude, and the acceptance of the principles of evolution made possible a satisfactory theory of state origin." This we feel is rather a negative attitude to assume especially in the light of the rare contributions of statesmen and diplomats of ages past. Whether this be an inherent failing in the book or not, we prefer to leave to the individual reader to determine. At any rate it seems to pervade the work to such an extent that didactic statements which leave little credit for the men and peoples of former ages, are quite frequent, and to an entirely open-minded critic seem at least a little selfish. This, we are frank to say, is an extreme view to take of Professor Gettell's excellent work. Few are qualified to discuss the broad subject which the author has chosen and treat it in all its aspects in an entirely satisfactory manner. He who can succeed in discussing the major portions of it from a broad, fair viewpoint has done a gigantic work to which few others can compare. This Professor Gettell has done and has done well. His work will no doubt find great use as a text book and should be included upon the shelves of all students of political science because in its description of the past can the best valuation of the present be found.

Cadence System of Close Order Drill. By Major Bernard Lentz. Menasha: George Banta Publishing Co. 1924. 75 cents.

WHEN all is said and done, the perfection of close order drill depends upon the ability of the instructor to give his commands correctly, and the corresponding ability of those who are executing them to do so with cadence and rhythm. Therefore any text which has for its objective the training of both components along a definite line is to be welcomed.

In this little booklet Major Lentz has prepared a very thorough and comprehensive text which should be of decided advantage to the instructor as well as to those who are studying under him. The text has a great many diagrams showing best practice and good form, and the first edition, which was gotten out in 1919, is now brought up-to-date with numerous changes which benefit the text considerably.

Virginia War History in Newspaper Clippings. By Arthur Kyle Davis. Richmond: Virginia War History Commission. 1924. $1.50 paper-bound, $2.00 cloth-bound.

THIS is a very unique volume covering all activities of the various Virginia military units and individuals who participated in the World War. The references are to newspapers published during the war period and since in the various sections of the State, and comprise a very distinctive source-book for the general history of Virginia and for local erudition.

The suggestion naturally arises that such a reference book descriptive of the participation of a state in the World War is equally valuable not only for Virginia and Virginians but for all other states as well. Possibly other such compilations have been made elsewhere, but they have not come to our notice. True, some of the state war commissions have performed notable service in preserving the war records of their various units and personnel, notably the State of Connecticut, where a similar commission has already performed exceptional service in this respect. Other states might well adopt similar methods for the preservation of their local records.

This is a book covering Virginia's World War history as told in newspaper clippings. It is essentially an index of all activities grouped under suitable functional heads. These comprise, among others, "Virginians of Distinguished Service," "Virginia Schools and Colleges in the War," "Virginia Organizations and Draft Law," "Virginia Committees and Communities in War Time," "Navy and Transport in Chesapeake Bay," "Virginia Soldiers and Sailors Overseas," "The Red Cross in Virginia," "War Work and Relief Organizations," and "Post-War Conditions and Activities." Each section has been compiled by a committee well qualified to prepare it, under the general direction of a well known Virginian in cooperation with other citizens. For example, the topics under the section "Virginians of Distinguished Service" have been collated under the Chairmanship of Hon. Thos. Nelson Page, former Ambassador to Italy, who had as his associate W. G. Stanard, Secretary of Virginia Historical Society of Richmond. The general editors of the work are Messrs. Arthur Kyle Davis of Petersburg, Va.; President Edwin A. Alderman, University of Virginia, and James Branch Cabell of Dumbarton, Va.

As in all previous crises in American history, the sons of Virginia have not been lacking in thorough coöperation and wholehearted aid. With relation to the World War this is amply shown by a perusal of "Virginia War History in Newspaper Clippings." Those who have followed the developments of ordnance since the war are well acquainted with the excellent work that has been performed by one of Virginia's sons, Major LeRoy Hodges, who has presented one of the best treatises on "Post War Ordnance" that has appeared in print. Major Hodges is but one of the many public spirited citizens of that State who have materially added to the wealth of information and interest which have come as one of the by-products of the World War. References to all these activities are readily available in this book.

The Society of American Military Engineers announces the recent publication of "Topographic Mapping," by Maj. L. B. Roberts.

This book is somewhat different from anything heretofore printed and fills a long felt want among engineers. Without the technicalities or intricate formulae of the text-book, it discusses in detail the making of topographical maps. Those inexperienced with the plane-table can plot a reliable map from the clear explanations of the text.

The volume may be procured from the Society of American Military Engineers, Mills Building, Washington, D. C., at $1.50.

Recent Patents

Brief Descriptions of Inventions of Interest to Ordnance Engineers

Compiled by W. N. Roach, Chief, Patent Section, Office of the Chief of Ordnance

THE following recently issued patents in the field of ammunition are of particular interest:

Ammunition

H. P. MARTIN and O. E. Lucas, assignors to M. L. Experimental Limited, have been granted patent No. 1,533,199, which discloses a primer for electrically fired ammunition in which a thin wire, preferably of tungsten or platinum, is housed within the primer cap with its end in electrical contact with the cap and its center in contact with a rivet by which the parts are held in assembly but which is insulated from the cap. The wire is designed to heat almost instantly to a temperature high enough to ignite the primer mixture.

Patent No. 1,533,756, has been granted to U. Panigatti, assignor to Metallurgia Bresciana Già Tempini, for a time fuze. The invention relates to that class of time fuzes in which the time train is divided between two or more rings and its object is to provide means for locking the rings so that succeeding rings will not be accidentally turned in setting a preceding ring. For this purpose locking members, specifically balls, are provided and are so arranged that the lock of each ring is automatically released upon full revolution of the ring immediately preceding it.

B. Grotta, assignor to Atlas Powder Company, has been granted patent No. 1,533,798, for a secondary charge for compound detonators. The patent covers a detonator consisting of a nitro-aromatic compound and an oxygen carrier, used with a primer consisting of fulminate of mercury and a heavy metal azide.

Patent No. 1,534,126, has been granted to O. D. Lucas and F. G. L. Johnson, assignors to Vickers, Ltd., for a fuze for bombs and other missiles adapted to be dropped from aircraft. This fuze is so constructed that when the bomb strikes a solid object the fuze will be fired instantaneously whereas, when the fuze strikes water it will not fire until after a predetermined interval of time. The mechanism is also so constructed that when the time train is fired the instantaneous firing mechanism is automatically locked against operation.

U. C. Tainton has been granted patent No. 1,536,164, for a projectile. This invention covers a specific form of projectile composed of a plurality of explosive members connected by flexible connections, the projectile being formed to separate after leaving the gun to liberate the flexibly connected explosive members.

F. G. L. Johnson, assignor to Vickers, Ltd., has been granted patent No. 1,536,219, for a shell fuze. This fuze is of the sensitive percussion type, the firing pin or stricker being normally held in unarmed position by centrifugally operated locking members which are held in locking position by a member released on set-back. A light shear wire passes through holes in the striker, the holes being larger than the wire so that the wire is normally out of contact with the forward surface of the holes, through which structure it is claimed the wire will not be subjected to shearing stress by reason of heavy blows received during transport or while loading.

Col. Alten S. Miller, Ord. Res., has been granted patent No. 1,538,131, for a time fuze. This is a constant pressure time fuze in which the timing rings are so arranged that the powder in subsequent rings will not be ignited until the train in the preceding ring has been completely consumed, thereby assuring a uniform rate of evolution of gases.

Patent No. 1,547,208 for a percussion fuze has been granted to Samuel Wiley, Picatinny Arsenal. This fuze is intended primarily for use with grenades and is so constructed that it cannot operate until a certain time has elapsed after discharge of the grenade. This fuze is held in unarmed position through means including a combustible train, which is not released until the combustible substance has been consumed.

E. A. Sperry and T. H. Phillips have been granted patent No. 1,537,713 for a drag rudder for gravity bombs. The rudder is in the form of a parachute and in its open position is an inverted parachute. There is also means connected between the bomb and rudder or parachute for automatically controlling the movement of the parachute.

W. L. Taylor, assignor to S. J. De Lanoy, has been granted patent No. 1,539,609, for a life conserving grenade. The object of the invention is the provision of a grenade which may be safely used for practice purposes. The body of the grenade is made up of light, somewhat resilient, material formed in sections, the joints between sections being comparatively easily separated so that no shattering of the grenade shell is had.

W. L. Lukens, assignor to Bethlehem Steel Company, has been granted patent No. 1,539,947 for a fuze for projectiles. This fuze is completely inclosed within the shell and is adjustable to explode the shell after a predetermined time or at the instant of striking a target or at a predetermined interval after striking a target.

Patent No. 1,542,169 has been granted to C. H. Pearson for a fuze. The invention discloses a fuze in which the firing pin or striker acts along a line at right angle to the axis of the fuze.

Artillery

THE following patents relating to artillery are of special interest:

William R. Wood has been granted patent No. 1,535,007 for a method for removing liners from cylinders. This method consists in heating the liner along one or more narrow strips extending from end to end of the liner. The softening of the metal along these strips will, due to the pressure exerted by the jacket cause the metal to buckle inward thereby separating the liner from the jacket.

Patent No. 1,538,825 for an apparatus for determining the data for the laying of guns indirectly, has been granted to A. Kooiman. The main object of the invention is the production of an apparatus of this character which is very simple and the parts of which are of comparatively small dimensions so that it may be used in confined spaces.

Small Arms

THE following patents relate to Small Arms:

J. M. Browning has been granted patent No. 1,533,966 for an automatic rifle. The invention relates to a specific construction of an automatic rifle of the gas operated type.

J. M. Browning has also been granted patent No. 1,533,967, for an automatic rifle. This invention relates to automatic rifles of the gas operated type and specifically to the provision of the cover plate for the ejection opening which may be manually operated to cover and uncover said opening, in combination with which is a safety device for positively locking the action slide when the cover plate is in position over the ejection opening.

J. M. Browning has been granted a further patent No. 1,533,968 for an automatic rifle. This invention like the previous one provides means for covering and uncovering the ejection opening combined with a safety device to prevent firing when the ejection opening is covered.

S. H. Bang has been granted patent No. 1,534,486 for a self-loading fire arm. The invention covers a special form of detachable hood for the muzzle of a gas operated gun, said hood being provided with a gas chamber so constructed that powder gas slush will not be deposited in a position to prevent full forward movement of the piston.

Patent No. 1,535,459 has been granted to E. A. Frederickson for an attachment for revolvers. Patent covers a specific form of device for attaching a flash light to a fire arm by which the object fired at may be illuminated.

N. E. Methlin, assignor to Schneider et Cie, has been granted patent No. 1,535,619 for a multibarrel gun. The inventor has devised a brake mechanism for multibarrel guns so constructed that the recoil of one barrel will cause the running out of the other barrel.

Patent No. 1,538,243, for a combined support and flash hider for guns, has been granted to Capt. Walter T. Gorton, Ord. Dept., U. S. A., of Springfield Armory. The patent covers a specific form of flash hider intended primarily for use with machine guns and so constructed as to form a support for the muzzle of the gun.

Staniszlaw Olszowiec. has been granted patent No. 1,540,494, for a gun. The patent covers a special form of electrically actuated firing pin through means of which the inventor claims the strain of pulling the trigger is avoided.

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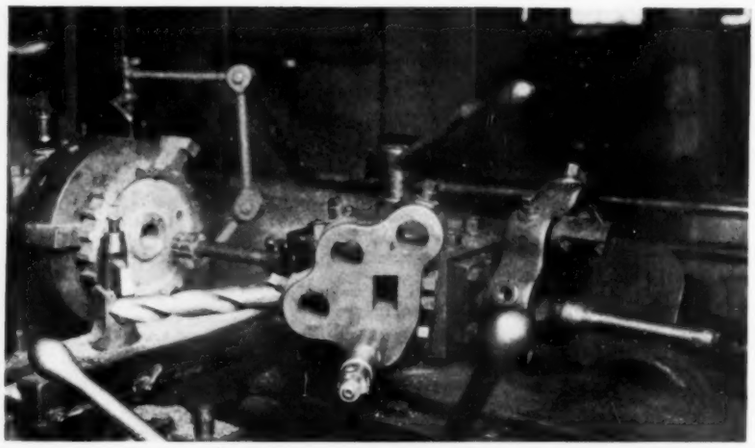

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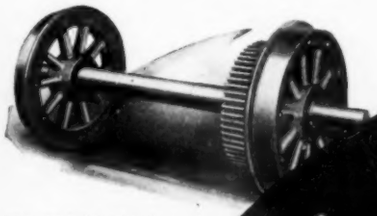

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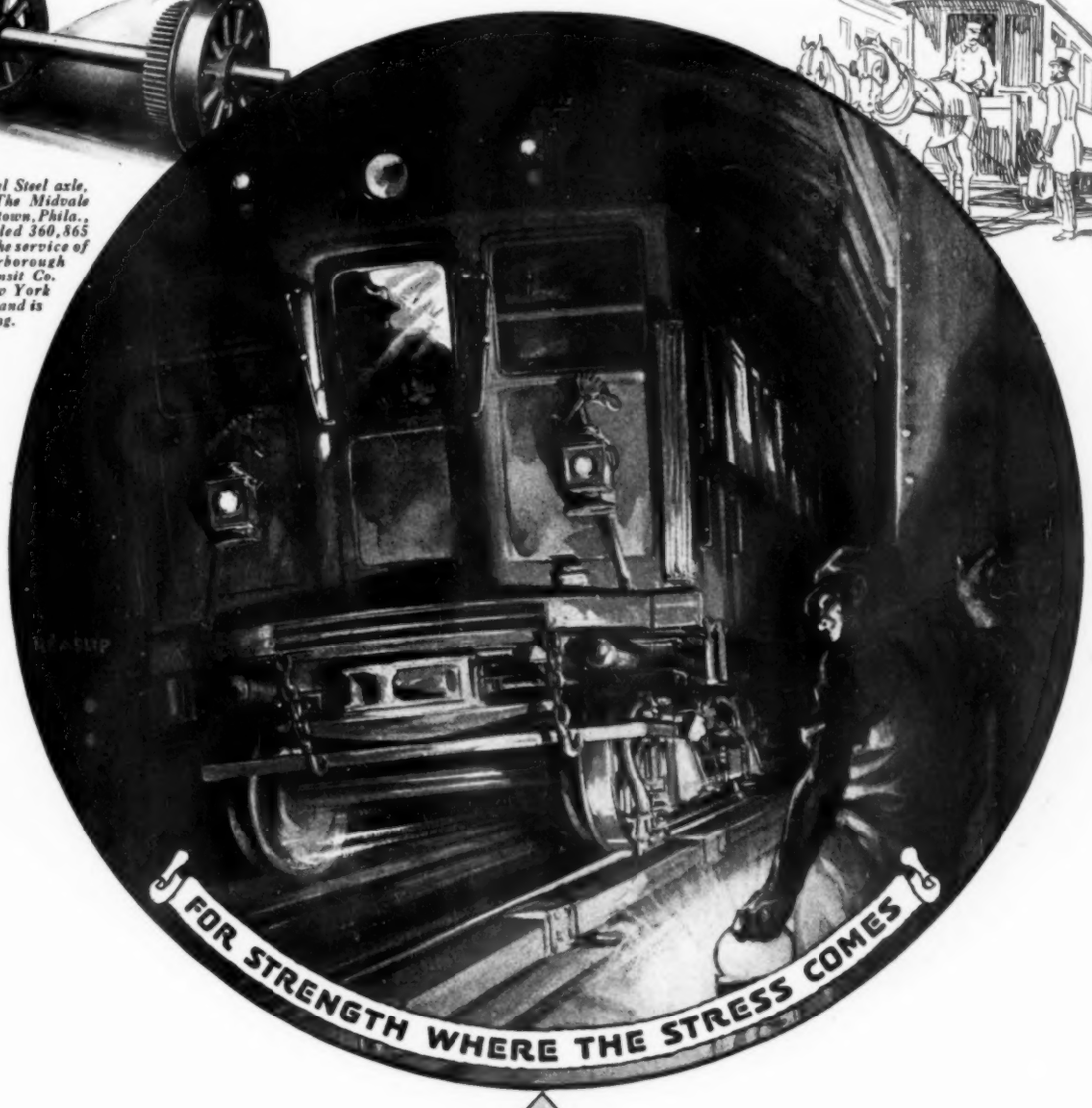

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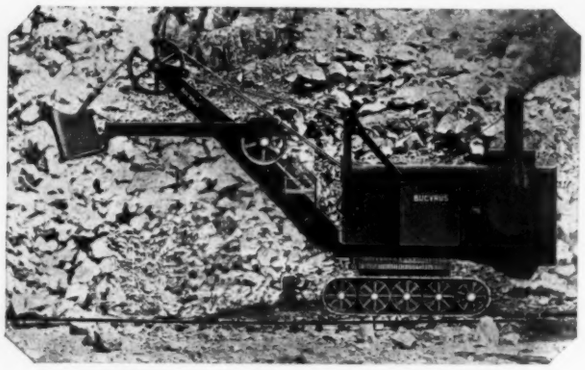

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